NOTICE

All drawings located at the end of the document.

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DRAFT

TECHNICAL MEMORANDUM 1

Data Compilation
Volume 1 - Text

ROCKY FLATS PLANT
700 Area
(Operable Unit No. 8)

U. S. Department of Energy
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

April 1994

A-OU08-000098

REVIEWED FOR CLASSIFICATION/UCNI U
BY G T Ostdiek 870 NU
DATE 4-12-94

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AES	Associated Environmental Systems
AQD	Air Quality Division
ARAR	applicable, relevant, or appropriate requirement
ASI	Advanced Sciences, Incorporated
bgs	below ground surface
BS	building sump
CB	catch basin
CCl_4	carbon tetrachloride
CCTV	closed circuit television
CDH	State of Colorado Department of Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CI	cast iron pipe
ComRad	Community Radiation Monitoring Program
CMP	corrugated metal pipe
DOE	U S Department of Energy
EG&G	EG&G Rocky Flats, Inc
EOC	Emergency Operations Center
EPA	U S Environmental Protection Agency
EPOS	Emergency Preparedness Offsite Systems
EPM	Environmental Protection Management
FD	foundation drain
Freon TF®	trichlorotrifluroethane
HEPA	high efficiency particulate air
HPGe	high purity germanium

HSL	hazardous substance list
HSU	hydrostratigraphic unit
IAG	Interagency Agreement
ICP	inductively coupled plasma
ID	identification
IHSS	individual hazardous substance sites
Jacobs	Jacobs Engineering Group Inc
MCL	Maximum Contaminant Levels
mg/L	milligrams per liter
MGY	million gallons per year
MH	manhole
min	minute
NA	not analyzed
NaI	sodium iodide
NAAQS	National Ambient Air Quality Standards
n/r	not reported
NOx	oxides of nitrogen
NO_3	nitrate
OU8	Operable Unit No 8
PA	protected area
pCi/L	picocuries per liter
PM-10	particulates smaller than 10 microns
PSZ	Perimeter Security Zone
PVC	polyvinyl chloride
QA	quality assurance
RAAMP	Radiological Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act

RFEDS	Rocky Flats Environmental Data System
RFI	Remedial Facilities Investigation
RFP	Rocky Flats Plant
RI	Remedial Investigation
SAAM	Selective Alpha Air Monitor
SD	storm drain
SU	standard unit
SVOC	semivolatile organic compounds
SW	surface water
SWD	Surface Water Division
TAL	target analyte list
TCL	target compound list
TRAC	Terrain-Responsive Atmospheric Code
TSP	total suspended particulates
TTLA	Total Long-Lived Alpha
UST	Underground Storage Tank
UTL	upper tolerance limits
WWE	Wright Water Engineers
VOC	volatile organic compounds
μg/L	micrograms per liter

Approved By

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Director (Date)

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Project Manager (Date)

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Quality Assurance Program Manager (Date)

1.0 INTRODUCTION

Preparation of this document meets the Stage 1 Resource Conservation and Recovery Act (RCRA) Remedial Facilities Investigation (RFI) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RI) Work Plan requirements to compile data before proceeding with Stage 2 activities for Operable Unit No 8 (OU8) at the U S Department of Energy (DOE) Rocky Flats Plant (RFP) located in Golden, Colorado (Figure 1) The Stage 1 activities include data compilation of locations and sampling history of foundation drains, an evaluation of infiltration/exfiltration of storm and sanitary sewer lines, an evaluation of the site-wide air monitoring program, and additional data compilation for individual hazardous substance sites (IHSSs) 118 1, 118 2, 150.6, 150 8, 151, 172, 184, and 188 The Stage 1 work is being conducted under the Phase I RFI/RI for OU8 Environmental media sampling is part of a comprehensive, multistage program of site characterization, feasibility studies, and remedial/corrective actions currently in progress at RFP These activities are pursuant to an Interagency Agreement (IAG) among DOE, the U S Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated January 22, 1991 (DOE 1991a) The IAG program developed by DOE, EPA, and CDH addresses both RCRA and CERCLA requirements Additional information on the approved investigative activities for OU8 is contained in the *Phase I RFI/RI Work Plan, Operable Unit 8, 700 Area*

(EG&G Rocky Flats, Inc [EG&G] 1992) All quality assurance (QA) information, data quality objectives, and methods of investigation requirements for the investigation of OU8 are also included in the OU8 Work Plan (DOE 1993)

OU8 is located in the 700 Area on approximately 150 85 acres in the north-central industrialized area of RFP The boundary of OU8 is polygonal in shape and encompasses a majority of the Production (high security) Area of the plant site Figure 2 presents the locations of the 24 IHSSs for which Phase I RFI/RI activities are planned

1.1 PURPOSE AND SCOPE

The purpose of this data compilation is to identify the underdrain/foundation drain systems for buildings and structures in the Industrial Area of RFP, and to evaluate the influence of these drain systems on groundwater and surface water flow and constituent migration Data were compiled from a review of existing documentation on foundation drains, an evaluation of engineering drawings, interviews with knowledgeable personnel, and site reconnaissance Available analytical data were also reviewed to assess the quality of foundation drain water and the adequacy of the current monitoring program The infiltration and exfiltration information for the sanitary and storm sewers within OU8 was also examined to determine areas where constituents may be transported into or out of OU8 IHSSs by groundwater migration As required by the OU8 Work Plan, the current air monitoring conducted at RFP was investigated and a summary is included in this technical memorandum In addition, the history of several IHSSs were also investigated further to determine either pavement histories, nature of releases, or an evaluation of tank inspection records

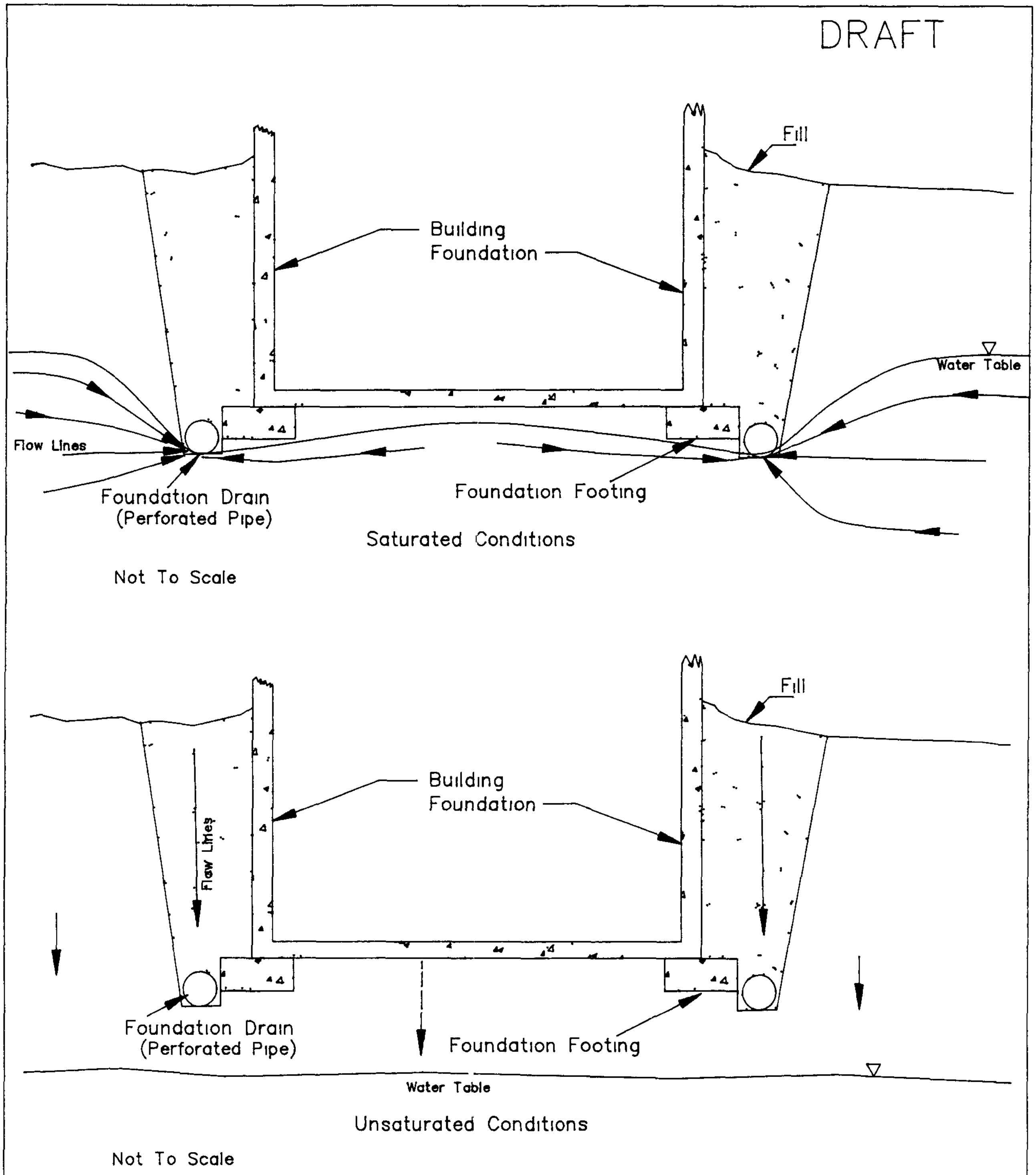
1.2 BACKGROUND

The nature and extent of potentially affected media within OU8 IHSSs is not specifically known, principally because of the lack of available analytical data Historical information, presented in the Historical Release Report (EG&G 1992b), provides general indications of the types of constituents that may be anticipated at the IHSSs. The boundaries of OU8 lie within the Industrial Area of RFP (Figure 2) As such, evaluations of the influences of foundation drains and storm and sanitary sewer systems on constituent migration pathways in soil and groundwater are important to determine future sampling requirements. In addition, air monitoring in specific IHSSs will be important, not only from a health and safety concern, but also to predict and mitigate the dispersion of constituents from these IHSSs. Additional historical information regarding specific IHSSs will be important for determining future sampling events in these areas

1.2.1 Foundation Drain Location Identification

Foundation drain systems were constructed to intercept and transport groundwater away from the foundations of many of the buildings at RFP to prevent flooding of the building's basement (or to prevent groundwater infiltration into the basement) A typical foundation drain consists of a trench or series of trenches backfilled with gravel or other free draining material A slotted or perforated pipe is installed at the bottom of each trench, as shown in Figure 3 The intercepted water is discharged to either a storm sewer, sanitary sewer, building sump, or surface outfall

The terms "foundation drain" and "footing drain" are used to describe the drains that are under buildings and along foundation footings Although foundation drains and footing drains are basically the same and may be identified under a structure or building based on location near a foundation or a footing, they serve the same purpose and often interconnect. For the purpose



U S DEPARTMENT OF ENERGY
EG&G Rocky Flats Plant, Golden, CO

FIGURE 3

OPERABLE UNIT 8
TECHNICAL MEMORANDUM 1

Schematic of
Foundation Drain Construction
and Groundwater Interaction

C \RFLATS\OU8\FIG3 DWG 05H60208

of this report, both foundation drains and footing drains will be identified as "foundation drains " Foundation drain water generally originates as groundwater However, the source of some of the foundation drain water could be storm water that originates from the direct piping of roof drains into the foundation drains or, more probably, from storm water infiltration through the backfill into the foundation drains

At RFP, foundation drain collection sumps located within buildings are referred to as building sumps (Yashan and Barros 1992) Foundation drain water typically drains by gravity to an outfall at a lower elevation, whereas water in sumps is generally pumped to a discharge location Any drain that exists below a building foundation is referred to as a subdrain A subbasement is a space below the basement of a building, typically designed for utility access, water collection, or storage

A footing drain and building sump sampling and analysis program was initiated in 1977 The 14 sampling stations (12 foundation drains and two building sumps) included in the current sampling program along with historical sampling locations are shown in Figure 2 Table 1 provides a summary of the current sampling program, as of March 1994 Table 2 provides descriptions of both the current and historical sampling stations Twenty-three sampling locations (13 foundation drains and 10 building sumps) were identified in 1977 (Werkema 1977) In 1983, updated information on the sampling locations was provided (Hoffman 1983)

The layout of the foundation drain systems and approximate outfall locations is contained in a series of Foundation Drain Plan drawings (Drawings 25581-1 through 25581-12) generated for several buildings in 1975 During the 1980s, the construction of several new buildings, building additions, and the Perimeter Security Zone resulted in both changes to the foundation drain systems of some buildings and relocation of several outfalls Many of these changes were not completely documented and, consequently, many of the new outfall locations are unknown

TABLE 1 - Summary of Current Foundation Drain and Building Sump Sampling
(March 1994)

Building Number	Sampling Date	Location ID	Manhole/ Outfall	Estimated Flow Rate	Comments
371	3-13-94	FD-371-2	Outfall	~4 L/min	Not sampled, flow has recently increased
		FD-371-3	Outfall	7 L/min	10" pipe of unknown material
		FD-371-MC	Outfall	4 L/min	Sampled at end of 8" CMP
447	3-20-94	FD-444-460	Outfall	>75 L/min	Unable to estimate flow, sample collected from outfall on hillside south of Building 664
707	3-13-94	BS-707-2	Manhole	NA	Sample collected from water approx 8ft bgs, approx 1 ft deep
771	3-13-94	FD-771-1	Manhole	NA	Not sampled, surface grate under water
774	3-13-94	FD-774-1	Outfall	5-7 L/min	Sample collected from pond near outfall
	3-13-94	FD-774-2	Outfall	NA	Not sampled, dry
	3-13-94	FD-774-3	Outfall	<1L/min	Not sampled, inadequate flow
779	3-13-94	FD-779-1	Outfall	~1L/min	Not sampled as a result of low discharge rate
790	3-13-94	FD-790	Manhole	~4L/min	Sample collected from bottom of manhole at southwest corner of building

TABLE 1 - Summary of Current Foundation Drain and Building Sump Sampling (March 1994)

(cont'd)

Building Number	Sampling Date	Location ID	Manhole/ Outfall	Estimated Flow Rate	Comments
865	3-20-94	BS-865-1	Manhole	NA	Sample collected from bottom of vault west of building, ditch to the north was dry
865	3-20-94	FD-865-2	Manhole	3 L/min	Sample collected from sump on east side of building
883	3-20-94	BS-883-1	Manhole	NA	Sample collected from sump near southwest corner of building
910	3-13-94	FD-910	Manhole	NA	Sample collected from manhole/sump located 14ft below ground surface, unable to estimate flow rate
991	3-13-94	FD-991-2	Manhole	2 L/min	Sample collected from sump in utility tunnel

NOTES

bgs = below ground surface
CMP = corrugated metal pipe
L = Liter
min = minute
NA = Not Applicable
FD = Foundation Drain
BS = Building Sump

Table 2 - Current and Historical Foundation Drain and Building Sump Sampling Stations

STATION ID	SUMMARY of STATUS
FD-111-1	Identified by Werkema (1977) and Hoffman (1981) as "probably dry " Hoffman checked the sample location in 1983, and again reported that the station is a "drain in gully outside security fence north of the northwest corner of the building halfway to Sage Avenue" (Hoffman 1983). Barros (1992) could not locate the sample station Latest available sampling data is from 5 May 1991.
BS-111-2	Identified by Barros (1992) as a "sump located in southeast corner of the basement of Building 111." Sampled (as FD-111-1) in March 1994 (Barros 1994).
FD-371-1	Identified by Werkema (1977) and Hoffman (1981) Hoffman (1983) reports that the drain was abandoned in place, according to Drawing 25022-004.
FD-371-2	Identified by Werkema (1977) and Hoffman (1981). Hoffman (1983) field checked the location and reiterated that the drain "daylights in the gully southeast of the southeast corner of Building 374 " That location was last sampled March 1981. Barros (1992) stated that the drain "was capped, [and] removed from service sometime between 1977 and 1983, and should be deleted from the sampling program " The outfall was rerouted to the northeast, and possibly connected to FD-371-3. However, water still drains from the FD-371-2 outfall, and the station was last sampled on 15 June 1991.
FD-371-3	Identified by Werkema (1977) and Hoffman (1981) Field checked by Hoffman (1983). Barros (1992) reported that the drain "is still in service and will continue to be sampled." Currently sampled (Barros 1994).
FD-371-4	ID number was "reserved for future location" by Werkema (1977) Hoffman (1981) stated that the drain daylights southwest of FD-371-3 on the west side of the access road to the 517/518 substation Field check revealed that station could not be located (Hoffman 1983) Never sampled.
FD-371-5	Identified by Werkema (1977) as a "storm drain grating across from the loading dock at the southwest corner of the building [371]." Hoffman (1981) stated that FD-371-5 "daylights northeast of the 517/518 substation." Could not be located in the field by Hoffman (1983) One sampling record (March 1981) exists.

Table 2 - Current and Historical Foundation Drain and Building Sump Sampling Stations

STATION ID	SUMMARY of STATUS
FD-371-6	First identified by Hoffman (1981) as daylighting northeast of the 517/518 substations Could not be located in the field (Hoffman 1983) Never sampled.
FD-371-MC	The sampling point for station FD-371-MC was described by Visocky (1993) as a metal culvert near outfall FD-371-1. The source of the water is steam condensate Earliest record of sampling is March 1993. Currently sampled (Barros 1994).
FD-444-1 FD-444-460	Identified by Werkema (1977) and Hoffman (1981) as "directly north of the southwest corner of the building.. outside of the security fence " Hoffman (1983) adjusted the sampling station to "directly south of the southwest corner of the building, outside of the security fence " Renamed FD-444-460 by Barros (1992), although the sample location did not change. Currently sampled (Barros 1994).
BS-444-2	Identified by Werkema (1977), Hoffman (1981) and Hoffman (1983) as a "sump inside building at the southeast corner of the 'snake pit' " Barros (1992) noted that the location is now connected to the process waste system and would no longer be sampled The sump was last sampled in September 1980.
FD-516-1	Identified by Hoffman (1981) as a drain located on the south side of the road into the 516 power substation Hoffman (1983) stated that the drain is slightly south and west of the current sampling location and a culvert helps identify the location. Barros (1992) noted that the location will be moved, and the current location described in Hoffman (1983) is downgradient of the actual sump collection point The drain was last sampled on 17 December 1989.
FD-559/561	Identified by Barros (1992) as a drain located east of Building 561, Door 1 and south of Building 559, Door 6 The drain is identified by a manhole cover Last sampled as part of the routine sampling program on 25 July 1992.
FD-707-1 750-Culvert	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a storm drain outlet across the road from east side of the 750 parking lot Deleted from the sampling program per Barros (1992). The station was last sampled on 07 March 1992

Table 2 - Current and Historical Foundation Drain and Building Sump Sampling Stations

STATION ID	SUMMARY of STATUS
BS-707-2	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a sump in a pump pit between the cooling tower and Building 707 This sump was also identified by Barros (1992) who noted that "according to current information the sump is still in service," and the sampling point would not be changed. Currently being sampled (Barros 1994).
BS-707-3	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a sump in the "old" process drain manhole outside Door 3 to Building 778 Barros (1992) noted that the site requires further investigation to determine if the process waste system has been altered, and until the determination is made, the site will not be sampled The sump was last sampled on 15 September 1989
FD-771-1	Identified by Werkema (1977) and Hoffman (1981) as a "drain located in the bank of the gully between the parking lots northwest of the building." Barros (1993) identifies the drain as located approximately 50 feet southwest of the southwest corner of the old 773 guard post. Currently being sampled (Barros 1994).
BS-771-2	Identified by Werkema (1977) and Hoffman (1981) as a "sump in Room 146." The sump was last sampled in June 1980
BS-771-3	Identified by Werkema (1977) as a "sump in elevator pit." No sampling records exist
BS-771-4	Identified by Hoffman (1981) as a "drain located on the flat ground west of FD-771-1 " Barros (1992) used the ID number for the "new outfall to Building 771 footing drain", and stated that the metal grate covering the sample collection point should be removed for sampling. The drain was last sampled on 17 December 1989.
FD-774-1	Identified by Werkema (1977) and Hoffman (1981) as a "drain located just east of Building 770." Hoffman (1983) stated that the sample was collected from the eastern most drain, and the drain just east of Building 770 is a storm drain that should not be sampled Barros (1992) described the drain as being located east of Building 770 and identified by the sign that marks Surface Water (SW) sampling location SW84 Currently being sampled (Barros 1994)

Table 2 - Current and Historical Foundation Drain and Building Sump Sampling Stations

STATION ID	SUMMARY of STATUS
FD-774-2	Drawing 37728-002 (rev May 9, 1990) shows outfall 774-2 as a 4-inch PVC pipe that drains the foundation of the north addition According to Wagner (1993) and Visocky (1993), the pipe was intended to discharge to the small pond north of the building, but is consistently dry. Outfall FD-774-2 has never been sampled; however, it is checked at each sampling event and is usually dry.
FD-774-3	According to Drawing 15501-013-M (rev. July 20, 1990), outfall 774-3 is a storm drain located on the hillside northeast of Building 774 The storm drain is connected to the 4-inch PVC foundation drain on the south side of the east addition The foundation drain is usually dry and has never been sampled.
FD-779-1	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a drain line that runs between ponds 207C and 207A, with an outlet on the hillside Werkema (1977) identified this location as FD-77-1. Barros (1992) described the drain as located on the hillside north of the solar ponds, identified by the broken concrete culvert with the red sandstone rocks Barros (1992) also noted the drain was still in service, and the sampling point would not be changed Currently being sampled (Barros 1994)
FD-790	Identified by Barros (1992) as a new drain located in the manhole on the southwest corner of Building 790. Currently being sampled (Barros 1994)
FD-850-1 FD-860-1	Identified by Hoffman (1983) as a "drain located approximately 50 feet south of Building 860 outside the Plant security fence." Barros (1992) describes the drain as located in the Buffer Zone south of the southeast corner of Building 850 and also that the drain is still in service. Barros (1992) also noted that the drain was identified as FD-860-1 before 1986 and as FD-850-1 since then. Early laboratory summary reports, however, refer to the station as FD-850-1 The station is usually dry and has therefore never been sampled.
BS-865-1	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a "sump in manhole on west side of building " Barros (1992) described the sump as located in a pump pit on the west side of Building 865 and identified by a "square shape metal cover on the pump pit " The sump was last sampled on 12 December 1993 (Barros 1993). The station was identified as FD-865-1 by Barros (1994) and is currently sampled (Barros 1994)

Table 2 - Current and Historical Foundation Drain and Building Sump Sampling Stations

STATION ID	SUMMARY of STATUS
BS-865-2	Described by Barros (1992) as a new drain located outside Door 1 of Building 865 that is the collection point for the Building 865 foundation drain. The drain is currently sampled (Barros 1994).
FD-881-1	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a "drain on hillside outside of security fence south of the middle of the building " All sources report that cattail growth identifies this location Barros (1992) noted that the site no longer required sampling because of the installation of a french drain on the 881 hillside. The drain was last sampled as part of the routine sampling program on 05 May 1991
BS-881-2	Identified by Werkema (1977) and Hoffman (1981) as a "sump in elevator shaft by the boiler room " The sump was last sampled in August 1978.
BS-881-3	Identified by Werkema (1977), Hoffman (1981), and Hoffman (1983) as a "sump under the stairway in the northeast corner on the first floor " Barros (1992) noted that the location would no longer be sampled because of access problems within the building to the area of the sump. The sump was last sampled on 09 June 1990
BS-883-1 FD-883-1	Identified by Werkema (1977), Hoffman (1981), Hoffman (1983) as a "sump pump in manhole directly west of the southwest corner of the building " Barros (1992) described the drain as located in a manhole outside of Door 17 on the southwest corner of Building 883 and identified by an elevated manhole approximately 2 feet above the ground Barros (1992) also noted that the drain is still in service with the same sampling point The station has been called FD-883-1 since 1993, and is currently being sampled (Barros 1994).
FD-886-1	Barros (1992) describes this site as a manhole at the northeast corner of Building 875 used as a collection point for the Building 886/875 tunnel foundation drain Last sampled 12 December 1993 (Barros 1993)
FD-886-2	Visocky (1993) describes a 6-inch corrugated metal pipe that slopes south to collection manhole FD-886-2 located on the west side of Building 886. The manhole was last sampled on 12 December 1993
BS-887-1	Identified by Werkema (1977) and Hoffman (1981) as a "sump in the northwest corner of the lowest section." The sump was last sampled in March 1980.

Table 2 - Current and Historical Foundation Drain and Building Sump Sampling Stations

STATION ID	SUMMARY of STATUS
FD-910	Barros (1992) described the drain as located in a manhole on the north side of Building 910 and identified by a manhole covered by the piping on the north side of the building. Barros (1992) also noted that this location has been sampled in the past as "Building 910 manhole." Currently being sampled (Barros 1994).
FD-991-1	Identified by Werkema (1977) and Hoffman (1981) as a "drain in gully outside security fence due east of the northeast corner of the building." Hoffman (1983) states that the drain is located inside the security fence. Barros (1992) noted the discrepancy and added that the drain may have been relocated to a sump in the southeast corner of the basement. The drain was last sampled on 26 April 1993.
BS-991-2 FD-991-2	Barros (1992) described the sump as located in the southeast corner of the basement of Building 991 and identified by the metal cover bolted to the floor. Currently being sampled as FD-991-2 (Barros 1994).

The locations of foundation drain and building sump sampling stations were modified in 1992 A spill of radioactive water in Building 371 (May 23, 1992 to May 25, 1992) and a chromic acid spill in Building 444 (spring 1989) caused concern within the EG&G Rocky Flats Surface Water Division (SWD) over the potential for foundation drains and building sumps to transport constituents into soil and groundwater and surface discharge Prompted by this concern, SWD attempted to pinpoint the locations of both unidentified and previously identified foundation drain outfalls and building sumps The updated sampling location information and plans to expand the sampling analytes to include volatile and semivolatile organics were announced in an October 5, 1992 letter by Steve Barros (SWD) (Barros 1992) Yashan and Barros (1992) provided building by building descriptions of the foundation drain systems and offered explanations for several of the discrepancies between past and present sampling locations The report stated that further investigation is necessary to adequately characterize most of the foundation drains

1.2.2 Sampling Frequency and Analytical Suites

According to available data, sampling and analysis of foundation drain and building sump waters has been performed since the late 1970s However, Dow may have performed sampling of some drains in the early 1950s (Blaha 1994) No results or documentation of this sampling have been found to date A program was established in the mid-1970s to identify foundation drain systems for buildings within the Industrial Area and to locate their outfalls The outfalls and sumps were sampled approximately three times per year (Hoffman 1981) to provide early identification of subsurface contamination No documentation of the sampling of foundation drains and building sumps from 1983 through 1988 was found during this investigation It is possible that the foundation drains and sumps were not sampled during that time, although Kirk (1994) recalled that the hiatus in foundation drain sampling lasted approximately two years Sampling of foundation drain and building sump water was reinitiated in 1988 and continues to date

The initial list of analytes included gross alpha, specific conductance, nitrates, pH, and total dissolved solids Gross beta and tritium were added in 1980 Arsenic, lead, mercury, potassium, selenium, and thallium were added to the analyte list in 1988 In 1989, inductively coupled plasma (ICP) screening for 19 additional metals was initiated, and screening for organic compounds in foundation drain and building sump samples began in 1992

Foundation drain and building sump samples currently are analyzed for gross alpha, gross beta, tritium, nitrate, pH, conductivity, total dissolved solids, target analyte list (TAL) metals (sometimes hazardous substance list [HSL] metals), target compound list (TCL) semivolatiles and TCL volatiles Under the current program, the schedule for analysis of volatile and semivolatile compounds will be changed to require annual sampling if there are no detections in samples from three consecutive sampling events

1.2.3 Infiltration/Exfiltration of Sanitary and Storm Sewers

The storm sewer system at RFP consists of more than 33,000 linear feet of piping and an estimated additional 33,000 linear feet of open channels (Advanced Sciences, Incorporated [ASI] 1991a) The sanitary sewer system consists of approximately 35,000 linear feet of piping, ranging in diameter from three to twelve inches (ASI 1991b) In addition to the existing sanitary sewer system, some of the old sewer lines have been abandoned in place and disconnected from the system (EMC Engineers, Inc , and KKBNA, Inc , 1985)

An examination of the infiltration and exfiltration into and out of the storm sewer and sanitary sewer lines at RFP will yield a better understanding of the potential for migration of chemical constituents to and from groundwater and soils ASI (1991b) characterized, to the extent possible, the presence, flow rate, and type of infiltration/inflow or exfiltration conditions that exist in the sanitary sewer system

Closed circuit television (CCTV) inspections of storm and sanitary sewer lines of the 400 Area, engineering drawings, and detailed high (spring 1992) and low (fall 1992) water level maps were used to determine areas of the sanitary and storm sewer system that would be prone to infiltration or exfiltration of constituents through joints, cracks, and other breaks in the closed conduit Industrial area sanitary and storm sewer pipeline maps that illustrate infiltration- and exfiltration-prone areas were prepared

1.2.4 Air Monitoring

Air quality monitoring within the plant boundaries has been ongoing since the 1950s. The current RFP effluent monitoring program includes real-time screening, biweekly filter collection and screening, and a monthly filter composite analysis of beryllium and radiological constituents of concern Study samples are also collected at a few locations for tritium analysis Particulate samples are continuously collected at numerous locations in and around RFP These samples are composited monthly for laboratory analyses of specific radioisotopes

1.2.5 Additional Data Compilation, Specific IHSSs

Pavement histories in IHSSs, 118 1, 118 2, 150 6, 150 8, 172, and 184 will provide important information in determining the media for sampling in these areas For example, if the paving occurred before a release, a sample of the asphalt that has been laboratory-analyzed for radiological constituents will be important to determine migration pathways and remediation techniques At IHSS 151, where a release of diesel fuel from an underground storage tank occurred, evaluating the tank inspection history will determine Stage 2 tank and pipeline inspection investigations for this IHSS Further clarification of the nature of a heavy metal release at IHSS 188 will help define the laboratory analyses for media collected at this IHSS

Additional information on the investigative activities for OU8 is included in the OU8 Work Plan (EG&G 1992a).

1.3 REPORT ORGANIZATION

This technical memorandum is organized into the following 10 sections:

- Section 1 0 discusses the purpose and scope of the data compilation, the background summary, and the report organization

- Section 2 0 summarizes the information sources used including existing documents, engineering drawings, aerial photographs, interviews of knowledgeable personnel, onsite reconnaissance, and analytical data

- Section 3 0 provides a detailed, building-by-building description and map of each foundation drain system that has been identified within the Industrial Area at RFP

- Section 4 0 summarizes the sampling frequency and analytical results for foundation drains and building sumps Analytical results were compared to background concentrations in surface water and groundwater Trends in radionuclide and metals concentrations over time were also evaluated

- Section 5 0 discusses the sanitary sewer and storm sewer systems and summarizes the results of infiltration/exfiltration studies and video inspections The invert elevations of the sanitary and storm sewers were compared to spring (high) and fall (low) 1992 water table elevations for the alluvial portion of the upper hydrostratigraphic unit to determine areas of the sanitary and storm sewer system which would be prone to infiltration or exfiltration of constituents through joints, cracks, and other breaks in the closed conduit In addition, this section discusses proposed foundation drain and building sump sampling

- Section 6 0 describes the current air monitoring program at RFP A summary of the current site-wide air monitoring program and a map, showing location and frequency of sampling, are provided

- Section 7 0 provides a discussion of the additional data compilation for specific IHSSs

- Section 8 0 provides a summary of the findings of the additional data compilation tasks

- Section 9 0 contains a list of references used in the preparation of this document

- Appendix A provides a list of the engineering drawings that were reviewed for foundation drain compilation.

- Appendix B includes written summaries of conversations with knowledgeable personnel to support the conclusions of this technical memorandum

- Appendix C contains selected aerial photographs of RFP, showing the construction and routing of foundation drains

- Appendix D consists of a table of water level and monitoring well construction information used in the creation of Figures 5 through 19

- Appendix E contains meeting notes and memoranda that address the location and/or sampling of foundation drains and building sumps Included in this appendix are (1) a retyped copy of a 1952 memo about liquid waste disposal at RFP, (2) summary notes from a meeting between EG&G SWD, Jacobs Engineering Group, and Wright Water Engineering personnel, and (3) two memoranda from Mr Steve Barros (SWD) to Mr Andy Carpenter (Jacobs Engineering Group Inc [Jacobs]) regarding foundation drain and building sump sampling

- Appendix F contains field notes from both the March 1994 sampling events and from site reconnaissances

- Appendix G provides a list of the engineering drawings reviewed for the IHSS data compilation

Approved By

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Director (Date)

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Project Manager (Date)

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Quality Assurance Program Manager (Date)

2.0 SOURCES OF INFORMATION

Information for this report was obtained from existing documents, engineering drawings, aerial photographs, knowledgeable EG&G personnel and subcontractors, onsite reconnaissance, CCTV video footage of actual RFP storm sewer lines of the 400 Area, and the Rocky Flats Environmental Data System (RFEDS)

2.1 EXISTING DOCUMENTS

The following documents, listed in chronological order, were reviewed for information on foundation drains, building sumps, and sampling locations

Shepherd, B P 1952 (June 13) Dow Chemical Company internal memorandum, "Liquid Waste Disposal at Rocky Flats Plant," 6 p This letter, from B P Shepherd to F H Langell, outlines the various methods of waste collection and disposal at RFP Sanitary, storm, and process waste systems are described for Buildings 71, 81, 23, 41, 74, 44, and 95 (These were later renamed as Buildings 771, 881, 123, 441, 774, 444, and 995, respectively)

Werkema, M V 1977 (May 19) Rockwell International, internal letter, "Locations of Building Sump and Foundation Drains " This letter, from M V Werkema to N E Moody, contains a table that presents building sump and foundation drain sampling locations for the early sampling program

Hoffman, N D 1981 (December 17) Water Quality Data for Foundation Drains and Building Sumps From 1977 Through 1981, unpublished report This report summarizes water quality data from foundation drain and building sump sampling from 1977 through 1981 Tables of analytical results are included

Hoffman, N D 1983 (October 4) Rockwell International internal letter, "Locations of Foundation Drains and Building Sumps - Update " This letter provides updated information on foundation drain and building sump sampling locations, with clarifications

Barros, Steve 1992 (October 5) EG&G Rocky Flats interoffice correspondence, "Footing Drains and Building Sumps " This letter provides updated information on foundation drain and building sump water sampling locations, including plans to expand the list of analytes

Yashan, Dean and Steve Barros 1992 (November 2) A Description of Rocky Flats Foundation Drains, SWD-012-92, 48 pp This report summarizes the foundation drain and building sump sampling locations, building by building, at RFP Maps and tables of sampling locations are included

Advanced Sciences, Inc 1993 (April) Video tape of the inspection of the FD-444-460 outfall, viewing time approximately 4 hours

Hayes, Bill 1993 (April) *Non-Storm Water Discharge Locations and Sampling at Rocky Flats*, SWD-010-93, 10 pp This document defines nonstorm water discharges and identifies 90 nonstorm water discharge locations at RFP, including 19 foundation drains or building sumps The remaining 71 locations are utility pits The document outlines plans to sample these stations

In addition, RFEDS, the master database for RFP environmental data, was queried for foundation drain data from 1992 to present

2.2 ENGINEERING DRAWINGS

Available engineering drawings were reviewed for all buildings within the Industrial Area to determine whether they were constructed with a foundation drain system Efforts were made to obtain original design drawings, "as built" drawings (of original building construction), and drawings for any additions or renovations to the building structure A list of the drawings that were reviewed is provided in Appendix A

Several assumptions were made regarding the information contained in the engineering drawings These assumptions are listed below

- If a drawing was stamped "as built," it is assumed that the elevations provided on the drawing had been verified and are accurate However, this may not always be the case Mr Paul Grabrowski, the EG&G plant surveyor, stated that due to budget constraints, many of the drawings for buildings were stamped "as built" with very little effort to verify the elevations Mr Grabrowski reported that the drawings probably indicate the correct design and slope of drains, but the elevations should not be used for design criteria The elevations shown on the figures in this report are invert elevations, which refers to the elevation of the inside bottom of the drainage pipe

- The elevation values are assumed to correspond to mean sea level and not the Rocky Flats Coordinate System, unless otherwise stated, based on conversations with Mr Paul Grabrowski (1994)

2.3 PREVIOUS VIDEO INVESTIGATIONS

In April 1993, ASI performed a CCTV inspection of the outfall FD-444-460 (ASI 1993) The inspection was performed to determine the layout of the storm sewer system and was reviewed by Jacobs in an effort to determine whether any foundation drains were tied into this system Mr Tyler Smart (ASI) was interviewed for information pertaining to the video (Smart 1994) The outfall, located on the hillside south of Building 664, is sampled under the current program

It is the surface outlet for a major storm sewer system draining the 400 Area The outfall was constructed in August 1987 (Trujillo 1994), and two drains that previously discharged onto the hillside were rerouted to it

A 24-hour CCTV video footage is known to exist for the storm sewer system of the entire plant This footage could not be obtained for review for this draft technical memorandum It is possible this video footage may have been classified Efforts are currently being made to locate the video and ascertain whether it is classified An appropriate individual will then review the tape for information pertaining to this study It is expected that the video will be made available before the finalization of this document

2.4 PHOTOGRAPH REVIEW

A photograph search and review was conducted by Wright Water Engineers, Inc to evaluate past activities that may have affected Building 124 and 400 Area buildings Three types of photographs were included in the review ground level, oblique, and aerial

Photographs reviewed for the activities affecting the 400 Area buildings were primarily from the late 1980s These photographs were reviewed to locate any disturbances caused by footing drain rerouting The focus of this photograph review was the outfall south of Building 440 and the hillside area south of Building 664

2.5 PERSONAL INTERVIEWS

Several people were interviewed for information regarding the foundation drains and outfalls at RFP including the following

- Steve Barros, EG&G Surface Water Division;
- Leslie Dunstan, EG&G Surface Water Division;
- Dan Wistrand, EG&G Surface Water Division,
- Dean Yashan, EG&G Surface Water Division,
- Nancy Kirk (Hoffman), EG&G (Waste Programs),
- Edward Mast, EG&G (Remediation Project Manager);
- James Koelmel, EG&G (400 Area Operations),
- Ron Steckline, EG&G (400 Area Utilities);
- John Lyons, EG&G (800 Area Utilities),
- Paul Grabrowski, EG&G (Engineering, Building 130),
- Rick Wagner, EG&G (Building 774),
- Sharon Wilson, EG&G (Building 991),
- Jerry Bentzinger, EG&G (Building 776/777);
- Carl Gibson, EG&G (Building 779),
- Mark Burmeister, EG&G (OU1 Treatment Facility Operations),
- Tyler Smart, Advanced Sciences, Inc ; and
- Frank Blaha, Wright Water Engineers

The information gathered from these interviews is summarized in the building-by-building descriptions in Section 3 0

On December 22, 1993, a meeting was held with EG&G SWD personnel (Blaha 1994). Jacobs and SWD reviewed the drawings for foundation drain outfalls that had been identified and shared knowledge about rerouting of foundation drain outfalls that had not been documented on the drawings

2.6 ONSITE RECONNAISSANCE

A number of onsite reconnaissance of the industrial area were conducted to locate foundation drain outfalls and verify information that had been gathered The objectives of those site reconnaissance were (1) to identify the outfall locations and determine whether they correspond to the locations shown on the engineering drawings, (2) to make visual observations regarding flow, (3) to evaluate the adequacy of the current sampling locations, and (4) to determine the destination of the effluent, if any.

The first site reconnaissance was conducted on November 30, 1993 Mr Steve Barros (SWD) escorted reconnaissance personnel to most of the foundation drain outfall and current sampling locations A second site reconnaissance was performed on December 6, 1993 A third and final site reconnaissance occurred on February 3, 1994 inside the protected area (PA)

A member of the reconnaissance team also accompanied the foundation drain sampling crew in March 1994 Observations and sketches of the sampled drains were made at that time This information was also used to prepare the building-by-building drawings in Section 3 0 of this technical memorandum

2.7 ANALYTICAL DATA

Available analytical data were reviewed to determine the quality of foundation drain waters Leslie Dunstan (SWD) provided data from 1988 to 1991. No pre-1988 analytical data were found, with the exception of the results included in Hoffman (1981) More recent data (1992-1993) were received in electronic format from RFEDS The RFEDS contains analytical data for building sumps and foundation drains for 1992 through 1993 only (Rigor 1994)

Approved By

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Director (Date)

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Project Manager (Date)

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Quality Assurance Program Manager (Date)

3.0 FOUNDATION DRAIN AND OUTFALL LOCATIONS

This section provides a detailed, building-by-building description of each foundation drain system that has been identified within the Industrial Area at Rocky Flats Plant The primary use of each building is described briefly in the subsection title In addition, each building is illustrated in a map which includes foundation drain and storm drain locations, outfall locations, invert elevations, historical, current, and proposed sampling locations, OU8 IHSS locations, topography, and high (spring 1992) water table contours Figure 4 is an index map to the detailed figures for each building.

3.1 BUILDING 111 - ADMINISTRATION

The Basement Floor Plans, (Appendix A) (Drawings 1-1664-11, rev January 8, 1965 and 1-1665-11, rev February 27, 1961) and the Foundation Drain Plan (Drawing 25581-8, rev December 9, 1975) for Building 111, show a 4-inch tile drain around the perimeter of the basement foundation. The type of backfill used around the drain system and foundation was not recorded The finished grade elevation is approximately 6,030 feet The drain slopes from the center of the south wall of the basement toward the northeast corner The outfall location is 130 feet north of the building in the drainage ditch as indicated on the engineering drawings (Appendix A)

Werkema (1977) described the outfall as located north of the northeast corner of the building However, Hoffman (1981, 1983) indicated that the outfall was located north of the northwest corner of the building SWD personnel performed a field inspection of the drainage ditch but did not locate the outfall (Yashan and Barros 1992) A possible outfall location was identified during the December 6, 1993 Jacobs site reconnaissance. Rip-rap has been placed on the slope of the drainage ditch, north of the northwest corner of the building, for erosion control Although a discharge pipe was not found, a slight depression of the ground leading away from this location may indicate where a trench was dug to reroute the drain pipe This location was dry on December 6 and 7 The layout of the foundation drain, invert elevations, and suspected outfall locations are shown in Figure 5

From 1978 through 1991, surface water samples were collected at sample station FD-111-1 in the drainage ditch near the suspected outfall The station was deleted from the sampling program because it is normally dry (Barros 1992)

The foundation drain pipe may have been rerouted as a result of the construction of Building 115 (Yashan and Barros 1992, Blaha 1994) in 1983. The Site Utility Plans (Drawing 15501-027-M, rev. July 20, 1990) show a manhole located north of the northeast corner of Building 111 The Building 111 foundation drain may have been rerouted to this manhole which is connected to a sanitary sewer pipe extending south along the east side of the building Removal of the cover during the February 1994 site reconnaissance revealed that the manhole is a cleanout for the sewer A north-sloping, 6-inch corrugated metal pipe connects into the sewer at this location It could not be determined whether the foundation drain for Building 111 was connected at this location The Site Utility Plans also show a manhole on the west side of Building 115 that connects into a storm drain. The storm drain discharges into the drainage ditch near the location of the suspected outfall The foundation drain pipe may have been rerouted to this manhole However, this location was field checked in January 1994, and the manhole for the storm drain could not be located This may indicate that the storm drain was never constructed or that it was removed and the 1983 Site Utility Plans do not reflect the change

Based on the Basement Floor Plans (Appendix A), a sump is located near the southern end of the basement Yashan and Barros (1992) report that this sump may be the collection point for the foundation drain The engineering drawings reviewed (Appendix A) do not show a connection between the sump and the foundation drain Also, it is not possible for the drain to discharge to the sump assuming that the invert elevations of the drain are correct Based on construction characteristics of other buildings of similar age at RFP (Shepherd 1952), it is likely that the sump is the collection point for the floor drains in the basement of the building The sump was first sampled in April 1993 as BS-111-2 Based on all information reviewed, it is not known where the sump discharges

3.2 BUILDING 124 - POTABLE WATER TREATMENT

The Building 124 Foundation Plan (Drawing RF-24-F1-C, rev March 19, 1953) shows a 6-inch perforated, corrugated-metal pipe around the exterior of the foundation The layout of the foundation drain system and the invert elevations are shown in Figure 6 The type of backfill used around the foundation and the drain system is unknown The finished grade elevation is approximately 6,044 feet (Drawing 25581-3, rev June 13, 1975, Drawing RF-24-Y1-B, rev March 19, 1953, Drawing RF-24-109-B, March 19, 1953) Foundation drain water flows from the center of the west wall eastward and discharges to a manhole on the east side of the building (Drawing 25581-3, rev June 13, 1975) The manhole historically discharged through a 15-inch pipe into an outfall on the hillside south of the plant site

The foundation drain once daylighted south of Building 124, uphill from Woman Creek (Blaha 1994) SWD personnel have been unable to locate the outfall (Blaha 1994) and no pipes or ponded water were observed during site reconnaissances (Appendix F) Mr. David Webb, Building 124 Manager, stated that the manhole on the east side of the building is now dry and there is no discharge into it and that the outfall had been plugged at the manhole (Webb 1994) A sump was observed next to the manhole (Appendix F) and all building foundation drain water collects in this sump The sump is not shown on engineering drawings, (Appendix A) and the date of installation is not known The sump discharges into settling tanks that are part of the backwash treatment system The wastewater from this system is piped to cooling towers in the 400 Area where it is then distributed around the plant site for process needs

The outfall on the hillside was removed or rerouted (Drawing 27006-4, rev June 18, 1975, Photo 18333-00) before the foundation drain sampling program began Consequently, the foundation drain water for Building 124 has never been sampled

3.3 BUILDING 371/374 AND SUBSTATIONS 517/518 - PROCESS WASTE TREATMENT FACILITY

Based on the Area Plot Plans for Foundations and Storm Drains (Drawing 25022-004, rev August 19, 1980) for Building 371/374, foundation drains around the perimeter and beneath the building are constructed of 8-inch and 6-inch concrete pipe, respectively The backfill material around the pipe is indicated as compacted sand The layout of foundation drains for Building 371/374 and Substations 517/518 are illustrated in Figures 7 and 8 The figures illustrate six outfalls, three for Building 371/374 and three for the 517/518 substations that discharge into a north-flowing drainage ditch tributary to North Walnut Creek The six outfalls are summarized below

- Outfall 1 (FD-371-1), for the storm sewer located along the southern edge of Building 371, has been abandoned in place

- Outfall 2 (FD-371-2) was historically sampled at the discharge location for the basement foundation drain system shown in the Area Plot Plan (Drawing 25022-004, rev August 19, 1980) The outfall was rerouted northeast of the old outfall during the construction of the Perimeter Security Zone in 1983 (Drawing 27550-002, rev May 4, 1982) The new outfall is a 10-inch PVC pipe with a gate valve on the end located at a concrete headwall The observed flow rate was approximately 1 gpm during the March 1994 sampling event (Appendix F)

- Outfall 3 (FD-371-3) is shown as the discharge location for the subbasement foundation drain system (Drawing 25022-004, rev August 19, 1980) Outfall 3 was observed during the March 1994 sampling event flowing at a rate of about 1 5 gpm (Appendix F) The basement and subbasement drain systems (FD-371-2 and FD-371-3) may have been connected during the construction of the Perimeter Security Zone in 1983 and all of the discharge is believed to be through Outfall 3 (Appendix E)

- Outfalls 4, 5, and 6 are for the foundation drain system around the 517/518 substations The drain pipes for Outfalls 4 and 5 (FD-371-4 and FD-371-5, respectively) are shown as 6-inch PVC pipe The pipe for Outfall 6 (FD-371-6) is shown to be cast iron on Site Utility Plans drawings (Drawing 15501-011-M, rev July 20, 1990, Drawing 15501-019-M, rev. July 20, 1990). The backfill material used around the pipes is unknown.

Outfalls 4, 5, and 6 could not be located in 1983 (Hoffman 1983) During site reconnaissances (December 1993), water was observed flowing through a drainage channel on the hillside east of where Outfalls 5 and 6 are shown on Drawing 25022-004 (rev August 19, 1980) The source of the water may have been surface runoff or discharge from buried outfalls. Hoffman (1981) lists analytical data for samples collected from FD-371-5 in March 1981

The drain systems are connected Mr Dan Wistrand (EG&G, SWD) is confident that the FD-371-2 and FD-371-3 foundation drain systems are connected although the location and date of connection are uncertain Mr Wistrand stated that the roof drains for Building 371/374 are connected to the basement foundation drain system He has observed the outfalls during storm events and noticed a small flow increase at Outfall 2 and a significant increase in flow at Outfall 3 The discharge from Outfall 2 is believed to be water that enters the drain system after the point of connection to Outfall 3 (Blaha 1994)

Two sampling locations are currently associated with Building 371/374

- Station FD-371-MC is sampled at a metal culvert near Outfall 1 According to Mr Steve Barros, SWD, the source of the water is steam condensate (Appendix F) Samples are analyzed for the same parameters as foundation drain and building sump locations

- Station FD-371-3 is located at Outfall 3 The source of water is from the foundation drains around the perimeter and subbasement of Building 371/374

Historically, water samples were also collected at station FD-371-Composite, located in the drainage ditch down gradient from Outfalls 5 and 6 near the T771 complex FD-371-Composite was removed from the sampling program because of the historical data from surface water sampling locations further down gradient and the monitoring by OU6 (Barros 1992)

3.4 BUILDING 440 - MODIFICATION CENTER

Based on engineering drawings (Appendix A), a foundation drain system does not exist for Building 440 However, the Foundation Drain Plans for Drain Terminating Points (Drawing 25581-1, December 9, 1975) indicates one outfall for Building 440 on the hillside to the south The outfall shown on Drawing 25581-1 was for a storm drain that ran underneath Buildings 440 and 447 That outfall no longer exists and the pipe was rerouted to an outfall on the hillside south of Building 664 (Photos 35127-34, 37233-00, ASI 1993, Appendix F) The foundation drains, storm sewers, and outfalls for the 400 Area are shown in Figure 9

A CCTV video inspection of the storm sewer system for the 400 Area was performed in 1993 (ASI 1993) This video footage revealed that a manhole exists in the storm sewer lines west of the northwest corner of Building 440 Field notes state that "a 6-inch PVC [pipe] enters [the] vault at northeast corner from [the] east, possibly a foundation drain around Building 440" (Smart 1994) This pipe is not shown on the drawings (Appendix A), but is apparently connected to a sump pump Water was observed discharging through this pipe at a high velocity during the video inspection, and after a short period of time, the discharge stopped (Smart 1994) The source of the discharge is unknown and is considered a data gap for Building 440 The manhole has not been sampled

All foundation drain water from the 400 Area eventually discharges to the outfall south of Building 664 and is sampled under the current foundation drain sampling program as FD-444-460

3.5 BUILDING 444 - MACHINING AND LABORATORIES

Based on the Foundation Plans for Building 444 (Drawing 13608-44, rev March 3, 1953) a 6-inch foundation drain exists around the basement foundation The drain and backfill materials are unknown The foundation drains slope toward the southern end of the basement known as "Area Way 2 " Data compiled from drawings and interviews are presented in Figure 9

Drawings of the process waste system for Building 444 (RF-44-127, January 18, 1952) show a pipe labeled as "footing drain" connected to the sump in the basement of the building and a 4-inch pipe extending from the sump through the basement wall south of the sump Mr Ron Steckline (400 Area Utilities) confirmed that this pipe is the inlet to the sump The sump is the collection point for the foundation drain water (Steckline 1993, Shepherd 1952) The sump discharges to the process waste system and the water is treated in Building 374

Two outfalls may exist for Building 444 foundation drains, but the number and locations are unconfirmed (Yashan and Barros 1992) Sampling station FD-444-460, located on the hillside south of Building 664, is a major storm drain system outfall for the 400 Area (ASI 1993) Because a connection between the Building 444 foundation drain and the storm sewer has not been identified, station FD-444-460 is probably incorrectly named The second outfall has not been located Mr Trujillo (EG&G Civil Engineering) reported that the FD-444-460 outfall was constructed in August 1987 (Trujillo 1994)

3.6 BUILDING 447 - ASSEMBLY AND WASTE PROCESSES

The Floor Trenches and Underground Piping drawing (Drawing 1-3326-47, rev June 26, 1964) show that a 4-inch tile drain exists around the western half of the basement foundation The backfill material and finished grade elevation are not indicated The layout of the foundation drain system is shown in Figure 9 This drain connects to the "interceptor drain line," an 8-inch corrugated metal pipe that runs from north to south beneath the center of the building The drains slope to the east from the center of the west wall and connect to the "interceptor drain line" at the north and south walls of the building

The interceptor drain line historically discharged to the hillside south of the building as shown on the Site Utility Plans (Drawing 15501-052-M, rev July 20, 1990) The pipe is now connected to the storm sewer system (ASI 1993) that outfalls at the FD-444-460 sampling location south of Building 664

3.7 BUILDING 460 - NONNUCLEAR MANUFACTURING/STAINLESS STEEL MACHINING

According to engineering drawings (Appendix A), a foundation drain system does not exist for Building 460, although Yashan and Barros (1992) state that the system does exist Mr Ron Steckline (400 Area Utilities) confirmed Building 460 contains no foundation drains (Steckline 1993)

Based on the Storm Drain Layout (Drawing 36010-100, rev October 9, 1984), a storm drain system is located around the east, west, and south sides of the building The layout of this system is shown in Figure 9 The storm drain outfall was originally located on the hillside south of the building, but has been rerouted to the outfall south of Building 664 (ASI 1993, Photos 35127-34, 37233-00)

A video inspection of the storm sewer (ASI 1993) showed that ten 6-inch polyvinyl chloride (PVC) roof drain pipes enter the storm sewer along the west side of Building 460 (Smart 1994) The video also revealed that a 6-inch PVC pipe enters the storm sewer on the east side of the building, west of the northwest corner of Building 447 This pipe is possibly an abandoned sanitary sewer line or another roof drain from Building 460 or 447 (Smart 1994), and is not shown on any of the engineering drawings (Appendix A) The video also revealed groundwater infiltrating into the storm sewer system at several locations near Building 460 through cracks in the pipes and offsets at the joints

3.8 BUILDING 559 - ANALYTICAL LABORATORY

According to engineering drawings (Appendix A), a foundation drain system does not exist for Building 559 However, the tunnel between Buildings 559 and 561 does have a foundation drain, as shown in Figure 10 Drawing 23452-102 (rev January 5, 1973) shows a pit in Building 561 constructed with a 6-inch drain around its exterior In 1974, a similar pit was constructed in Building 559 with a foundation drain of 6-inch perforated pipe around the exterior of the pit (Drawing 23452-203, rev September 1974) The two pits are connected by an underground tunnel The Building 559 drain extends along the outside of the tunnel and ties into the existing drain for the Building 561 pit (Drawing 23452-203, rev September 1974)

Both drains (Building 559 pit and Building 561 pit) discharge to a sump between the two buildings, near the northwest corner of the Building 561 pit The sump formerly discharged to the storm sewer system west of Buildings 559 and 561, which discharged onto the hillside west of Substation 516 The outfall was historically sampled as FD-516-1 (Figure 8), but has been removed from the sampling program in 1992 as directed by Barros (1992) and the building sump, considered to be more representative of the foundation drain waters, was added as FD-559/561 In March 1993, the discharge from the sump was rerouted to the sanitary sewer system using aboveground flexible hose to Building 560 because carbon tetrachloride was detected in samples from the sump Because it was rerouted to the sanitary sewer system and is treated at the STP, the sump is not currently sampled (Barros 1994, Gibbs 1993)

3.9 BUILDING 707 - PLUTONIUM PROCESSING

Based on engineering drawings (Drawings RF-BZ-20451-05 through RF-BZ-20451-09, rev November 4, 1970), a 6-inch foundation drain system exists beneath Building 707 The pipes are surrounded by "graded filter material", however, the drain material has not been reported

The layout and elevations of the drains are shown in Figure 10 The drains beneath the building slope to the west and tie into a pipe that runs along the west side of the building This pipe ties into the storm sewer at the southwest corner of the building The storm sewer outfalls east of Building 707 at the 750 culvert, and the water eventually enters the B-series ponds

Sampling is currently conducted at BS-707-2, a vault next to the cooling tower south of the building (Figure 10) According to observations made during the March 1994 sampling event, the source of the water in the vault is likely to be surface water runoff or groundwater infiltrating through cracks in the concrete rather than foundation drain waters from Building 707 (Appendix F) Water from the vault discharges into the storm sewer system north of the vault (Drawing 15501-030-M, rev July 20, 1990)

Historically, samples were collected at station BS-707-3, a "sump in 'old' process drain manhole outside Door 3 to Building 778" (Hoffman 1981) According to Mr. Steve Barros (SWD), this location is no longer sampled because the sump has been dry since approximately 1992 (Appendix F)

The storm drain outfall (750 Culvert) has been included in the sampling program from the beginning The identification code was originally FD-707-1, although the discharge included water from Buildings 559, 750, 776, 777, 778, and 707, and surface runoff from the land east of the buildings Barros (1992) stated that the 750 Culvert was being sampled on a weekly basis and that FD-707-1 was scheduled to be removed from the program The SWD stopped sampling the 750 Culvert in August 1993 (Barros 1993, Appendix B)

3.10 BUILDING 771 - PLUTONIUM AND AMERICIUM RECOVERY

Based on the Foundation Drain Plan (Drawing 25581-5, rev December 9, 1975) and Site Utility Plans (Drawings 15501-012-M and 15501-013-M, rev July 20, 1990), the foundation drain system for Building 771 has three discharge locations on the northwest side of the building However, the Foundation Plan Section (Drawing RF-V71-10008, August 6, 1962) and Sewage and Drain Lines (Drawing RF-71-113-D, rev May 11, 1953) drawings show only the section of drain pipe along the north wall of the building and one of the discharge locations The drain pipe along the north wall of the building is a 6-inch vitrified clay pipe The layout of the foundation drain system for Building 771 and the invert elevations along the north wall are shown in Figure 11

A storm drain system comprised of cast iron pipe exists beneath Building 771, according to Underground Plumbing Plans (Drawings RF-71-100 through RF-71-104, rev May 11, 1953)

Several 6 inch downspouts that are presumably connected to the building roof drains connect to the storm drain system Numerous floor drains within the building also discharge into the storm sewer system, which discharges to Manhole No 3

The three discharge locations for Building 771 foundation drains and storm sewers are described below

- Discharge 1 is a pipe that discharges to Manhole No 3 near the northwest corner of Building 771 (Figure 11) Manhole No 3 originally discharged to ground surface north of Building 771 The outfall was rerouted to the storm sewer north of the plant site at an unknown date A construction drawing for the Perimeter Security Zone fence (Drawing 27550-050, rev May 10, 1982) indicates that the discharge pipe from the manhole is plugged and a gate valve has been installed on the pipe which connects to the storm sewer Mr Dan Wistrand (SWD) reported that the manhole discharges to the small pond on the north side of Building 774 (Blaha 1994), although drawings do not confirm this

- Outfall 2 is the southernmost outfall on the west side of Building 771, and it discharges from a 6-inch corrugated metal pipe to the ground surface west of the building, according to the Site Utility Plans (Drawing 15501-013-M, rev July 20, 1990) This outfall has not been located

- According to the Foundation Drain Plan (Drawing 25581-5, rev December 9, 1975), outfall 3 discharges to the storm sewer on the west side of the building This section of foundation drain was constructed for the addition on the west side of Building 771

The Building 771 sampling locations have changed through time Initially, station FD-771-1, west of the building, was the only Building 771 foundation drain sampling station (Werkema 1977) This station probably represented the southernmost outfall on the west side of the building and may have discharged at ground surface Hoffman (1981) identified a second foundation drain outfall and sampling station, FD-771-4, located on flat ground west of FD-771-1 Hoffman (1983) stated that these outfalls no longer exist because of construction of the Perimeter Security Zone in 1983. However, a review of the Perimeter Security Zone Plan (Drawing 27550-050, rev May 10, 1982) does not indicate that these outfalls were removed These sampling locations were deleted from the program and the outfalls were either rerouted to the storm sewer system or abandoned in place

The identification code FD-771-1 has been used for two separate locations Before 1983, FD-771-1 referred to the outfall pipe described above From May 1993 to the present, FD-771-1 refers to a location "approximately 50 feet southwest of the southwest corner of the old 773 guard post" (Barros 1992) This location is a surface inlet to the storm sewer system

Two sumps in Building 771, BS-771-2 and BS-771-3, have been sampled historically BS-771-2 was located "in Room 146" and was sampled from 1977 through 1980 BS-771-3 was located "in the Elevator Pit" (Yashan and Barros 1992) There is no record of the dates that BS-771-3 was sampled These stations have been deleted from the current program because the sumps are pumped to process waste and sampling would require special precautions (Hoffman 1983)

3.11 BUILDING 774 - OLD PROCESS WASTE TREATMENT FACILITY

Building 774 has undergone construction and foundation drain system changes since the building was constructed in 1952 The original building Plans and Elevations drawing (Drawing RF-74-

1-G, rev November 1953) indicates that a 6-inch tile foundation drain exists around the perimeter of the building and discharges to the ground surface north of the northwest corner of the building The discharge point may correspond to a storm sewer outfall FD-774-1, located northwest of the building, according to the Site Utility Plans (Drawing 15501-013-M, rev July 20, 1990) There have been several additions to Building 774, including the West Addition in approximately 1962, the East Addition in approximately 1965, the South Addition in 1973, and the Waste Treatment Addition (North) in 1990 The Foundation Drain Plans (Drawing 25581-6, rev December 9, 1975) indicates that 4-inch PVC foundation drains were constructed for the north and east additions The layout of these drains is shown in Figure 11

A foundation drain outfall and a storm drain outfall were constructed to accommodate the expanded drain system, according to the Site Utility Plans (Drawing 15501-013-M, rev July 20, 1990) An 8-inch foundation drain was also constructed along the south and west walls of an addition on the south side of Building 779 The foundation drain may discharge to this storm sewer

Three outfalls exist for the foundation drains for Building 774, one of which is sampled regularly under the current program The three outfalls are shown in Figure 11 and are described below

- Outfall FD-774-1 is a storm sewer discharge pipe located along the west side of Building 774 A segment of the storm sewer system intersects the west side of Building 774 (Drawing 15501-013-M, rev July 20, 1990), and the foundation drain for the southern building addition probably connects to the storm sewer there Hoffman (1983) describes the storm sewer outfall location as a sampling location, but the original foundation drains may or may not have been connected to the storm sewer A review of the 24 hour CCTV video footage of the storm sewer system would help to identify this connection

The northern addition to Building 774 was built at the location of the original discharge pipe and the pipe may have been rerouted during the construction Discharge from the storm drain (FD-774-1) flows into a small pond north of the building and into North Walnut Creek However, Yashan and Barros (1992) state that water from the pond is collected in the OU4 Interceptor Trench System and treated The outfall was flowing during the site reconnaissances (Appendix F) and is sampled regularly under the current program.

- Outfall FD-774-2 is a 4-inch PVC pipe that drains the foundation of the north addition (Drawing 37728-002, rev March 9, 1990) The pipe was intended to discharge to the small pond north of the building, but is consistently dry (Wagner 1993, Appendix F) The drain may have been blocked during construction on the north side of the building, but no documentation exists to confirm that the drain was rerouted or plugged Mr Rick Wagner (Building 774) stated that the drain was traced back from the outfall and was free from obstructions (Wagner 1994) Outfall FD-774-2 has never been sampled but is checked at each sampling event to confirm that it is dry The March 1994 sampling event confirmed that FD-774-2 was dry (Appendix F)

- Outfall FD-774-3 is a 6-inch corrugated metal pipe storm drain located on the hillside northeast Building 774 (Drawing 15501-013-M, rev July 20, 1990) A 4-inch PVC foundation drain on the south side of the east addition connects to the storm drain, which has never been sampled and is usually dry (Appendix F) Discharge from this outfall would be collected in the OU4 drain system and treated (Appendix F)

A subgrade drainage system was installed in Room 103 to alleviate flooding problems in the basement of Building 774 after the construction of the north side addition (Waste Treatment

Addition, Drawing 37728-002, rev March 9, 1990) The subgrade drainage system consists of a sump (2-foot 6-inch well casing) which extends approximately 3 feet below the basement floor (Drawing 29655-470, rev May 11, 1990) The sump pumps the groundwater from beneath the building into a holding tank at a rate of approximately 3,500 to 6,000 gallons per month (Wagner 1994) The water from the tank is transported by truck to Building 374 for treatment

3.12 BUILDING 732 - SUPPORT; BUILDING 776 - PYROCHEMISTRY, WASTE REDUCTION, AND PREVENTIVE MAINTENANCE; BUILDING 777 - ASSEMBLY AND PRODUCTION SUPPORT LABORATORIES; BUILDING 778 - LAUNDRY, LOCKER ROOMS, AND MAINTENANCE SHOPS

During data compilation tasks for Operable Unit 9, drawings were observed that identified foundation drains for these three buildings These drawing numbers are as follows (dates unknown)

Building 732	D25845-1 and 4
Buildings 776, 777, 778	D2545-1 Sheet 5

Preliminary efforts to obtain copies of these drawings were unsuccessful However, it is expected that these drawings will be obtained before the finalization of this Technical Memorandum The outlines of Buildings 776, 777, and 778 are shown in Figure 12 The foundation drains will be added once the referenced drawings are obtained

3.13 BUILDING 779 - RESEARCH AND DEVELOPMENT

Engineering drawings for the original Building 779 (Appendix A) do not show foundation drains although the local water table was recorded at approximately 5,975 feet during the spring of 1992 The bottom of the footing elevation for the basement is shown as 5,959 feet, approximately 20 feet below the elevation of the foundation drain on the building addition During a February 3, 1994 interview, Mr Carl Gibson (Building 779 Utilities) stated that he was not aware of any drains or sumps which would collect groundwater around the basement He stated that the basement frequently has problems with groundwater infiltrating through the foundation during the high water table months Four large concrete tanks are located beneath the basement of the building and extend approximately 30 feet below the basement floor Mr Gibson stated that groundwater infiltrates into one of the tanks through cracks in the concrete (Gibson 1994) These tanks are checked daily and the water is pumped to Building 374 for treatment

Based on the Foundation Drain Plan (Drawing 25581-7, rev December 9, 1975), a foundation drain exists for the Building 779 addition, which was constructed in 1968 The layout of the foundation drain system is shown in Figure 13 According to the Grading and Drainage Plan (Drawing 20112-01, rev September 12, 1968), a 6-inch open tile drain begins at the northern part of the western wall and continues along the northern wall of the building The drain slopes from the western wall to the east along the northern wall of the building and connects to a 10-inch vitrified clay storm drain The storm drain discharges onto the hillside north of the solar ponds (Drawing 15501-021-M, rev May 14, 1990)

During a number of site reconnaissance, two outfalls were observed on the hillside north of Building 779 One of these outfalls is the discharge point for foundation drain waters, however, it is uncertain which outfall The 24-hour CCTV video footage of the storm sewer system may be helpful in identifying these outfalls Sampling station FD-779-1, an 18-inch corrugated metal pipe on the hillside, has been sampled as representative of the foundation drain water from Building 779 since the initiation of the program During a number of site reconnaissance, water was observed flowing from outfall FD-779-1 at less than 0 25 gallons per minute (visual estimation) Discharged water is reportedly collected by the OU4 drain system (Barros 1993)

A second outfall from a 10-inch pipe approximately 10 feet to the east was also observed during site reconnaissance and the March 1994 sampling event (Appendix F) It is believed that this second pipe could actually be the discharge point for the foundation drains of Building 779, and it is uncertain whether the correct outfall is being sampled as FD-779-1 (Appendix F) The 10-inch pipe is currently being sampled as SW85 in the surface water sampling program

3.14 BUILDING 790 - LABORATORY AND SUPPORT

Engineering drawings (Appendix A) do not show foundation drains for Building 790, which was under construction at the time of the most recent drawings However, Barros (1992) stated that foundation drain FD-790 is located in a manhole, which is part of the storm sewer system near the southwest corner of the building The 24-hour CCTV video footage of the storm sewer system may be able to clarify the storm sewer and foundation drain layout for Building 790 The manhole was sampled as FD-790 for the first time in March 1994

3.15 BUILDING 850 - ADMINISTRATION

The First Floor Plan (Drawing 28234-106, rev December, 12, 1985) shows a 6-inch vitrified clay foundation drain around the perimeter of the basement The backfill material is unknown The layout of the drain system and outfall location are shown in Figure 14 The foundation drains in Building 850 slope from the northwest corner toward the southeast corner of the basement From there, the drain discharges through 6-inch vitrified clay pipe to an outfall on the hillside south of Building 850, approximately 50 feet south of the plant security fence

Hoffman (1983) referred to the outfall as FD-860-1 In 1986, the identification code was changed to FD-850-1 (Barros 1992) Barros (1992) stated that the outfall "is marked by vegetation which clogs the flow of water and makes sampling impossible" and "the vegetation will have to be removed if future sampling is desired " The outfall is usually dry and, therefore, has never been sampled FD-850-1 was removed from the sampling program in 1991

3.16 BUILDING 865 - MATERIAL AND PROCESS DEVELOPMENT LABORATORY

The Cast-In-Place Pile Plan (Drawing 21141-01, rev June 15, 1972) shows that Building 865 has a 6-inch perforated asbestos subdrain in four segments The details of each segment are illustrated in Figure 15 The southern segment slopes to the east from the southwest corner of Building 865 and connects to a 6-inch storm drain at the southeast corner of the building The storm drain flows north from the southeast corner of the building to a building sump (BS-865-2) south of Door 1 The southwestern segment also originates at the southwest corner of the building and flows to the north The northwestern segment flows to the south along the west wall and joins the southwestern segment in the middle of Building 865 The fourth segment flows from this juncture to the east, under the building, and discharges to the sump (BS-865-2)

The sump discharges to the east through a 2-inch steel pipe (Drawing 21112-01, rev June 12, 1972) that daylights at a low spot on the west side of the 800 Area portal guard post December 22, 1993 observations noted water flowing through this pipe BS-865-2 is sampled under the current foundation drain sampling program

Another sump, identified by Mr Steve Barros as BS-865-1, was observed on the west side of Building 865 (Appendix F) The sump was not found on engineering drawings (Appendix A), and the source and destination of the water in the sump have not been determined However, based on visual observations and conversations with Mr John Lyons (EG&G, 800 Area Utilities), BS-865-1 probably collects groundwater and discharges to the ditch west of the building (Lyons 1994) BS-865-1 is sampled under the current program

3.17 BUILDING 881 - RESEARCH AND GENERAL SUPPORT (PREVIOUSLY MACHINING)

Engineering drawings (Appendix A) show that Building 881 has three separate foundation/underdrain systems which discharge to different locations The three systems are (1) a foundation drain system located around the exterior of the foundation, (2) a storm drain system located underneath the building, and (3) a drain system located in the floor of the utility tunnels These systems are shown in Figure 16 The foundation drains and utility tunnel drains are discussed in the following sections

The Foundation Drain Plan for Building 881 (Drawing 25581-2, rev December 9, 1975) shows that the foundation drains around Building 881 are constructed of 6-inch perforated galvanized steel, with sections of 6-inch vitrified clay pipe. According to the Foundation Drain Lines plan

Approved by

Manager Remediation Programs 6 28,94

RFI Project Manager 6,28,94

2.0 OPERABLE UNIT 8 SITE CHARACTERIZATION

Information presented in the following discussion of IHSSs is taken from descriptions presented in the Historical Release Report (DOE, 1992a and 1992b) for the RFP, engineering designs drawings, and facilities drawings For several IHSSs, this information was recently updated by Doty & Associates, Boulder, Colorado, as part of a subtask to preparing this Work Plan. This research has been included in the IHSS descriptions provided below and is also provided in Appendix B This research includes additional background information regarding release mechanisms, revisions to IHSS size and location, and the nature of operations and potential contaminants occurring at a given site. This research (Appendix B) is currently being directed to the EG&G Historical Release Report (HRR) manager and will be incorporated into quarterly updates of the HRR.

2 1 PREVIOUS INVESTIGATIONS AT OU8

Due to its location within the RFP and its size, OU8 is adjacent to and/or overlain by several other OUs, including:

- OU2 - 903 Pad, Mound and East Trenches
- OU4 - Solar Ponds
- OU6 - Walnut Creek Drainage
- OU9 - Original Process Waste Lines
- OU10 - Other Outside Closures
- OU12 - 400/800 Area Sites
- OU13 - 100 Area
- OU14 - Radioactive Sites

OU15 - Inside Building Closures and,

OU16 - Low Priority Sites.

Several of these OUs are either currently undergoing studies or have had studies completed recently that are likely to provide data supporting the determination of the nature and extent of contamination at OU8. In addition, several investigations and studies have been undertaken at OU8, in response to spills and other incidents related to the individual IHSSs These investigations (DOE, 1992a and 1992b, and EG&G, 1990c) and studies include the following.

- "774 Spill-Tank 66 Analytical Report," L.P. Johnson, 1981, EG&G Internal Report.
- "776 Utilities Compressor House Oil Spill," R.E. Smith, 1986, EG&G Internal Report.
- "Building 559 Groundwater Contamination," M.V. Werkema, 1977, EG&G Internal Report.
- CEARP Phase I, Effluent Pipe, 700 Area.
- "Decontamination of Building 76 and Environs Following Incident of June 12, 1964," J B. Owen, 1964.
- "Disposition of South Section of Clay Lined Pond in Relation to Proposed Building 79," E.S. Ryan, 1962.
- "Engineering and Geologic Investigation for Two Additions to Building No. 774, AEC Rocky Flats Facility," Woodward-Clevenger & Associates, 1970.
- Evaporation Ponds, A.H Voight, 1971.
- "Final SIR 87-6-774 1 Caustic Spill," D.O. Kissell and F.P. McMenus, 1987.
- "Fire--Building 71, September 11, 1957," J.B. Owen, 1957
- "History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek," J.B. Owen, 1974

- "Investigation of Radioactivity Found in 701 Building Sanitary Sewer Backflow and in 995 Building Outfall, June 7-13, 1972," Werkema, 1972

- "Oil Spill Documentation," M L. Pancio, 1986

- "RCRA Closure Plan Tanks T-40, T-66, T-67, T-68 Hazardous Waste Management Unit 55 for USDOE - Rocky Flats Plant Transuranic Mixed Waste," Rockwell, 1989.

- "Report of Investigation on a Recent Process Waste Pipeline Leak," C.T Illsley, 1980

- "The Composition of Pond 2A," R.L. Delnay, 1959.

Map Figure 2-1 illustrates the location of all known IHSSs and PACs that are currently known within the boundaries of OU8 Investigations regarding the potential for contamination to exist at many of these IHSS will be undertaken according to the schedule of investigations pertaining to the respective Operable Unit. The locations of IHSSs that will be discussed and investigated in this Work Plan for OU8 are indicated in purple on Figure 2-1. Table 2.1 lists the IHSS numbers and names of each site to be investigated during implementation of the Work Plan for Operable Unit 8 Table 2.2 lists the number of all IHSSs located within OU8 exclusive of those planned to be investigated in this Work Plan (i.e., Table 2 1), and all PACs and the Operable Unit in which it is currently located.

2 2 REGULATORY BACKGROUND AT OU8

The Phase I RFI/RI and all response activities performed by DOE under the IAG are planned so as to be consistent with CERCLA, the National Contingency Plan (NCP), RCRA, the Colorado Hazardous Waste Act, and pertinent EPA guidance documents However, the primary source of the scope of work for the OU8 Phase I RFI/RI is the IAG, which formulates a phased approach for investigation and remediation tailored to the particular requirements of RFP. According to the IAG, the Phase I RFI/RI will determine for each IHSS the source and extent of contamination in soil, sediments, surface water, groundwater and air; identify additional investigations work needed, and provide information for a Human Health Risk Assessment and Environmental Evaluation If further characterization of contamination within the OU8 area is required involving groundwater (alluvium and Arapahoe Formation), surface water, and biota, it is anticipated these will be addressed in a Phase II RFI/RI.

2.3 CURRENT CONDITIONS AT IHSSs WITHIN OU8

The current conditions described in this subsection are based on historical reports, review of historical photographs, site visits, and interviews with former and present RFP employees Figure 2-2 is a map of OU8 showing outlines of individual IHSSs. Figures 2-3 through 2-26 are photographs and detailed maps of each IHSS. The locations and sizes of IHSSs presented in this Work Plan are based on research of records and interviews with RFP employees and updated from the most recent HRR (DOE, 1992a and 1992b) The IHSS information was compiled considering recent information obtained by Doty and Associates which is present in Appendix B

2.3.1 IHSS 118.1 - Solvent Spills West of Building 730

IHSS 118 1 is related to a 5,000-gallon underground steel storage tank that contained carbon tetrachloride located adjacent to the west side of Building 730, just north of Building 776. Persons interviewed for the CEARP report recalled a spill of 100 to 200 gallons of trichloroethene (TCE) north of Building 776 prior to 1970. These persons did not recall any mitigation efforts to control the spill or clean-up operations. However, the practice at that time was to flush the affected areas with large volumes of water. No documentation was found detailing response to spills which occurred during filling operations in the 1970s (DOE, 1992a)

On February 26, 1976, corroded piping leaked carbon tetrachloride into the tank's sump pit. What has been described as a "considerable" quantity leaked and was subsequently pumped out of the pit onto the ground. Other documents indicate that this release was the result of a leaking valve (DOE, 1992a) It was speculated that the tank or its associated pipes in the sump could have been releasing the carbon tetrachloride into the ground (DOE, 1992a) Documentation was found which detailed the cleanup of spilled liquid, including that pumped onto the ground (Appendix B).

On June 18, 1981, the tank failed, releasing carbon tetrachloride into the sump. The tank was subsequently removed following this failure (DOE, 1992b).

IHSS 118.1 was originally defined as a 50- by 180-foot area between Buildings 776 and 701 (EG&G, 1990c). HRR information indicates that the tank was located adjacent to the west of Building 730. Therefore, it was proposed that this IHSS be re-defined as a 20- by 40-foot area centered around the former tank location adjacent to the west of Building 730 (DOE, 1992a). More recent information provided by Doty & Associates (Appendix B), indicate that IHSS 118.1 be re-defined as a 30- by 13-foot area located adjacent to the east side of building 701 (Figure 2-3)

Drawings, including D-13491A, D-13492A, and D-13493A, provide dimensions and details of the tank which may be of importance when planning the environmental investigation of the area. These drawings indicate that the length of the tank (north/south) was approximately 14 feet, and the diameter was approximately 8 feet. The south end of the tank was enclosed in a concrete structure which provided maintenance access and encased the piping. The dimensions of the concrete structure were approximately 6 feet wide, 12 feet long, and 12 feet deep. The wall thickness was approximately 9 inches. An 18-inch square sump pit located in the southwestern corner at the bottom of the structure provided drainage. The bottom elevation of the interior of the structure was at 5,976 feet and the top of the structure was at 5,988 feet. The ground surface around the structure was approximately 1 foot below the top of the structure This structure encased only approximately 3 feet of the south end of the tank. The tank was supported by the concrete structure and a concrete footing approximately 3 feet wide located at the north end. It is unclear from the design drawings how deeply the north portion of the tank (that was not enclosed in the structure) was buried. The material which had surrounded the north portion of the tank is unknown The ground surface around the tank location was diked (EG&G, 1990c)

The area is currently relatively flat and includes both paved and unpaved surfaces. Prior to 1968, the entire area was unpaved. The location is highly congested with overhead, ground-level, and underground pipes and utilities

2 3.2 IHSS 118.2 - Solvent Spill South End of Building 776

Available references state that IHSS 118.2 consists of a 5,000 gallon, above ground carbon tetrachloride tank located within a bermed area between the north side of Building 707 and the alleyway south of Building 778 (Figure 2-4) In June 1981, the tank ruptured and leaked solvent onto the ground, contaminating the soil. An unknown amount of carbon tetrachloride was released in this incident. The tank and the area of the spill were subsequently cleaned up. Materials that were contaminated, were boxed and shipped to Nevada and materials that were not were likely placed in the present landfill (IHSS 114) No documentation was found which further details response to this occurrence. It is not known whether sampling and analysis was conducted to verify the complete removal of contaminated soil (DOE, 1992b)

IHSS 118.2 was originally defined as a 30- by 70-foot area south of Building 776 (EG&G, 1990c) The HRR more precisely located this IHSS between the north side of Building 707 and the alleyway south of Building 778. More recent information provided by Doty & Associates (Appendix B) indicates that IHSS 118.2 be redefined as an area approximately 30 by 20 feet adjacent to the north side of Building 707 (Figure 2-4) The area occupies part of the long, narrow alley between Buildings 707 and 778

The surrounding area is flat and fully paved, and receives moderate traffic.

2.3.3 IHSS 123.1 - Valve Vault 7 Southwest of Building 707

IHSS 123.1 is related to leaks at Valve Vault 7 which is part of the New Process Waste Line system and controls the 800 Area main process waste line (Figure 2-5). This valve vault was constructed to replace the original vault (also designated Valve Vault 7), which was located west of Building 707 several hundred feet to the north. The original Valve Vault 7 was removed in March 1973 and this location constitutes IHSS 123.2 (EG&G, 1990c). The leading agency (Appendix B, CDH, April 21, 1992) has transferred IHSS 123.2 to OU9. Therefore, IHSS 123.2 has been removed from the OU8 Work Plan.

On April 4, 1983, a check valve in Valve Vault 7 malfunctioned, allowing process wastewater to backflow into the sump. The vault filled with process wastewater and overflowed. The high-water-level alarm system in Valve Vault 7 was apparently inoperative at the time of the overflow Process wastewater drained into an adjacent storm runoff collection system ditch near the Eighth Street and Sage Avenue and flowed east toward South Walnut Creek and the B-Series drainage ponds (Figure 2-5). Runoff was noticed flowing across the former 750 Parking Lot and through the Building 991 normal runoff drainage (Appendix B).

The transfer of liquid waste from the holding tanks at Building 881 was discontinued after wastewater was identified flowing out of Valve Vault 7 Temporary dikes were constructed to contain the overflow. A dam was constructed in the ditch east of the guard shack at Portal #1 and another dam was placed just west of Guard Shack 762 Drainage from the area was diverted to Pond B-1 (DOE, 1992b)

The malfunctioning check valve was repaired or replaced, the sump pump was replaced, and repair of the electrical system was initiated A new type of check valve was ordered for all the check valves in the waste transfer system. The ditch along Sage Avenue between Valve Vault 7 and Ninth Street was cleaned of all visible contamination. The excavated material was stored for drying in the old Building 771 parking lot which is neither an IHSS or a PAC (DOE, 1992a). Standard procedures would have monitored for radiation but nothing else. This area is a few hundred feet northwest of Building 771 (Figure 2-5) This area was used as a parking lot for Building 771, however, the pavement history is not known. Investigations of this area are planned as part of this Work Plan.

IHSS 123.1 was originally defined as a 30- by 30-foot area southwest of building 708 centered around Valve Vault 7, and immediately adjacent to the PA between the inner fence and the perimeter road (EG&G, 1990c). The HRR stated that IAG maps mislocated this IHSS in the same area as the Original Process Waste Line (OPWL) valve vault which is several hundred feet to the north (DOE, 1992a) The HRR suggested that based on this information, the proposed boundaries defining this IHSS in the IAG be extended to include the storm runoff collection system ditch near Eighth Street and Sage Avenue and continue to the extent of Pond B-1 (DOE, 1992a) More recent information provided by Doty & Associates (Appendix B), indicates that IHSS 123.1 consists of the area where the valve vault was located Specifically the area south of Sage Avenue (an area of approximately 40 by 40 feet) and the drainage ditch south of Sage Avenue and west of Ninth Street. Since the spill entered a pipeline at the intersection of Sage Avenue and Ninth Street, the IHSS does not extend beyond this point (Figure 2-5). Also included is the area of the old Building 771 parking lot.

The IHSS slopes gently to the east and includes both paved and unpaved surfaces. Access to the south of the area is restricted by the PA, while the perimeter road to the north is heavily travelled by RFP traffic Overhead electric lines and underground process waste lines exist in the area.

2.3 4 IHSS 135 - Cooling Tower Blowdown - Northeast of Building 374

IHSS 135 is related to cooling tower (Building 373) that serves Building 374 which was constructed in the mid-1970s In 1979, because of a concern of tritium possibly being in the water, a proposal was made that overflows and drain piping from the cooling towers should be made to the sanitary sewer (Appendix B) The cooling tower blowdown from this structure is currently piped into the sewage treatment plant. These cooling towers have had the ability since approximately 1981 to accept recondensed evaporator water from Building 374. Evaporator water is routinely sampled and analyzed and may be transferred to either the cooling towers or to the Building 443 boilers A 1989 water balance study indicated that 11.3 million gallons of recondensed Building 374 evaporator water went to the Building 443 boiler and 2 million gallons went to the Building 373 cooling towers This 2 million gallons of water was combined with other plant raw water for the cooling tower makeup water (Appendix B).

A holding pond is located south of the cooling towers, across a paved drive, and currently serves as secondary containment for Tanks 808A and 808B. The holding pond was originally clay lined and was used to contain surface runoff from around Building 374. It was concreted in approximately 1986 for the purpose of serving as secondary containment for the two tanks, which were constructed in 1986, as well as containing surface runoff A sluice gate is located at the northeast corner of the pond with a connecting culvert that directs water into a drainage toward North Walnut Creek (Appendix B)

Persons interviewed for the CEARP Phase I report indicated that areas near the Building 374 cooling tower were affected by blowdown water However, Building 374 personnel stated that blowdown water is routed through an underground pipe into the RFP's sanitary sewer system for treatment (DOE, 1992b) The underground blowdown water pipe extends out through the southwest corner of the cooling tower

IHSS 135 was originally defined as a 100- by 150-foot area southeast of Building 374 (Rockwell, 1986f), but the cooling tower is actually northeast of the building (DOE, 1992b). HRR information indicates that the pond was north of Building 374 at the turn in the asphalt road and that this IHSS is irregularly shaped Current information (Appendix B) updating the June 1991 Final HRR states that a 1981 event impacted the holding pond located to the south of the cooling towers Therefore, the IHSS boundary should be located around this holding pond and at the outlet of the culvert. The updated dimensions of this IHSS, as shown on Figure 2-6, are approximately 115 feet by 40 to 50 feet with a panhandle that extends approximately 50 feet to the northeast.

No documentation was found specifically identifying or describing the environment immediately surrounding the cooling tower as being impacted by the cooling tower blowdown (Appendix B). The ground surrounding the cooling tower is unpaved, flat, and is lightly used for storage (EG&G, 1990c).

2.3.5 IHSS 137 - Cooling Tower Blowdown - Buildings 712 and 713 (IAG Name. Building 774)

IHSS 137 is related to cooling tower Buildings 712 and 713 which are located adjacent to each other south of Building 774 and north of Building 777. Building 712, the westernmost of the two, was constructed in 1962 to service Buildings 776 and 777. Building 713 was constructed in 1966 to provide additional cooling tower capacity. During construction of Building 713, several laundry and process waste lines were rerouted to make room for the new building (RFP Engineering Drawing 14267-9 rev. A, Recommended January 19, 1966). It is unknown if these underground pipes were removed, rerouted, or abandoned in-place. The area surrounding these cooling towers, especially immediately south of the buildings, is characterized with an abundance of aboveground and underground pipes and other structures. Elevation of the ground surface near the buildings is approximately 5982 feet MSL Process waste invert elevations in the area south of the buildings are as deep as four feet, approximately 5978 feet MSL. Buildings 702 and 703 are pumphouses for Buildings 712 and 713, respectively The cooling tower sump for Building 712 is located between the cooling tower and the 702 Pumphouse (Appendix B) The Building 776 cooling towers blowdown water is treated in the wastewater treatment plant. It is thought that the blowdown water drains from the cooling towers through exterior underground pipes at the south end of the buildings (DOE, 1992b)

The cooling towers have been damaged by wind and rain and the west tower (Building 712) has been resided at least once Building 712 currently has open panel siding; Building 713 currently has open slat siding The slat siding allows some water to spray out of the tower onto the surrounding ground surface. The ground immediately around the east side of Building 713 was puddled from overspray during a August 20, 1992 visit. Building 712 was not operational on that day and has been inoperative for quite some time (Appendix B).

In the past, operation of the towers have been alternated seasonally; the west tower (Building 712), which has a higher cooling capacity, operated in the summer, while the east tower (Building 713) operated in the winter. Blowdown water from these facilities is routed into the RFP's sanitary sewer system for treatment (EG&G, 1990c). The cooling tower blowdown pipes also leave the towers along their south sides.

IHSS 137 was originally defined (Rockwell, 1986f) as a 50- by 150-foot area south of Building 774. It was proposed to change the dimensions to a 50- by 120-foot area and that the boundaries of IHSS 137 be redefined to encompass the south ends of Building 712 and Building 713 (DOE, 1992b) More recent information provided by Doty & Associates states that due to the age and use of the cooling towers, it is anticipated that the area surrounding and between the cooling towers has been affected by waters resulting from drift, blowdown, and leaks. Therefore, the IHSS boundary, as stated in the IAG and HRR, is proposed to be enlarged from the south end of the cooling towers to the entire area surrounding and between the cooling towers. The potential area of impact is difficult to estimate, no documentation has been located which describes or delineates the effected area. For the purpose of this initial investigation, it is planned to include a zone approximately 10 feet beyond the foundation of Buildings 712 and 713 (Figure 2-7) Also, due to a general lack of documentation, it is not possible to reliably estimate the area of affected surface from runoff that may have resulted from drift, blowdown, or leaks Again, no documentation has been found which identifies pathways other than to the north toward North Walnut Creek. The area of investigation and interest may be adjusted toward the north if initial investigation results indicate significant contamination within the proposed 10-foot wide zone surrounding the cooling towers (Appendix B).

The land surface surrounding Buildings 712 and 713 is flat and unpaved. Numerous underground interferences (possibly Process Waste Lines (PWLs)) are evident (EG&G, 1990c).

2.3 6 IHSS 138 - Cooling Tower Blowdown - Building 779

IHSS 138 is related to cooling towers near Building 779. The original Building 779 cooling towers were built in 1964 when construction of Building 779 was completed. The original cooling towers were relatively small structures located south of the present Building 779 cooling towers The present cooling towers, Buildings 784, 785, 786, and 787 were constructed in 1986. The original cooling towers were removed when those buildings were constructed. Building 783 is a pumphouse associated with the current towers and contains many of the ancillary piping.

A discussion of general cooling tower development at the RFP is described in detail in the narrative for IHSS 137. The current Building 779 cooling towers are separated for different functions and different plumbing. Cooling Tower 1, which consists of four units, is the West Chiller Cooling Water System, and is identified as Building 786. The one unit of Cooling Tower 2 is Building 785 and is the Process Cooling Water System. Cooling Tower 3, Building 787, is the East Chiller Cooling Water (Glycol mix) System. Cooling Tower 4 (Building 784) consists of four units and is the Standby Cooling Water System (Appendix B)

IHSS 138 is related to two separate releases from the cooling towers for Building 779 that occurred 14 years apart (DOE, 1992b). The first is a piping leak that occurred on December 8, 1976 in an underground line that connected to the original cooling towers and the second is related to an overflow event that occurred on December 8, 1990 Both events are described below

Utilities personnel at RFP recalled that the 1976 spill occurred when an underground water line for a cooling tower broke east of Building 779 and adjacent to the northwest corner of Building 727. The leak discharged approximately 400 gallons of cooling tower effluent into a storm sewer At the time, it was stated that the spill drained toward Trench No 6, which was part of the original surface-water and shallow groundwater collection system north of the solar ponds (Appendix B).

The second event occurred on December 8, 1990 when a sump filled and water backwashed into Building 756 Cooling Tower No. 2 and spilled out of the fan on the east side of the structure. An estimated 1,000 gallons of cooling tower water flowed onto the ground. According to Building 779 utilities personnel, the spray from the backwash extended no more than 5 to 6 feet east of the building (Appendix B)

IHSS 138 was originally defined as a 75- by 75-foot area northeast of Building 779 (EG&G, 1990c) The area of the cooling tower water line break is of smaller extent and located farther to the east than presented in the IAG as IHSS 138. It was proposed that IHSS 138 be redefined as a 50- by 50-foot area north of Building 727 (DOE, 1992b). The IHSS boundary presented in the IAG was concluded to be too large and too far west of where the 1976 event occurred. The reidentification of the site in the HRR is considered to be adequate for the location of the 1976 pipe leak. The effluent spilled toward Trench No 6, presumably through the storm water drains and channels At the time, these were monitored for radioactivity and were considered to be uncontaminated. The exact route the spill took is not known at this time and therefore cannot be mapped with accuracy (Appendix B) For this Work Plan, this portion of this IHSS will be considered a 50- by 50-foot area north of Building 727. The location area of the 1990 incident can be defined along the east side of Building 785 (Tower 2) extending six feet out from the building (Figure 2-8)

The area surrounding the towers is unpaved and relatively flat, and is heavily congested with trailers and storage containers (EG&G, 1990c). The area is marked by an abundance of aboveground and underground utilities and other structures (Appendix B)

2.3.7 IHSS 139.1(N) and 139.1(S) - Hydroxide Tank Area - Buildings 771 and 774

IHSS 139.1 was originally identified as a 25- by 250-foot area south of Building 771. However, this IHSS actually consists of two separate areas surrounding two aboveground caustic storage tanks and two aboveground condensate receiving tanks (EG&G, 1990c).

A potassium hydroxide (KOH) tank (IHSS 139.1(S)) is located approximately 55 feet south and 35 feet east of the southeast corner of Building 771 (Appendix B) (Figure 2-11). It was built some time between 1955 and 1964 The 5,400-gallon tank is of welded construction and appears to be in good condition presently. It is on a concrete base, which is also in good condition and is surrounded by a small, eroded, earthen berm (Appendix B).

A 6,500-gallon sodium hydroxide (NaOH) tank (IHSS 139.1(N)) is located adjacent to the north side of Building 774 (Figure 2-9) The NaOH tank was built some time between 1955 and 1964 (Appendix B) It is vertical and surrounded by insulation, which is in poor condition. Through the holes in the insulation, it is apparent that the sides of the tank are corroded, as is the base of the tank. The tank is surrounded by a corroded concrete berm which is approximately 18 inches high (Appendix B)

In addition to the two tanks described above, two 8,000-gallon tanks were once used as steam condensate tanks and are located approximately 45 feet north of the NaOH tank (DOE, 1992b and Appendix B), and at a lower elevation (Figure 2-10). These tanks were built some time between 1971 and 1978 (Rockwell, 1978). The westernmost tank receives overflow and contained liquid from the bermed area around the NaOH tank. The easternmost tank receives overflow from the westernmost tank. These two tanks, T-107 and T-108, have riveted construction. Standing water has been noted around the tanks. The bottom of the tanks appears to be corroded, and there is rust on the tops and sides of the tanks (Appendix B).

This Work Plan proposes that IHSS 139.1 be informally separated into two units. IHSS 139.1(N) consisting of both the NaOH and the steam condensate tanks and 139.1(S) consisting of the KOH tank. It is proposed that 139.1(N) be comprised of two discrete sites: a 25- by 25-foot area around the NaOH tank and a 30- by 40-foot area centered around the west condensate receiving tank. IHSS 139 1(S) is proposed to consist of an "L"-shaped area 25 feet wide and 140 feet long that includes the KOH tank and the line that transfers KOH into Building 771 (DOE, 1992b). Recent information accumulated by Doty & Associates (Appendix B) indicates the 139.1 (N) site consists of the two areas described above with redefined dimensions of approximately 20 by 20 feet and 70 by 35 feet (Figures 2-9 and 2-10) This information also indicates that IHSS 139 1(S) be redefined as a 35-by-25 foot area (Figure 2-11).

2.3.8 IHSS 139.2 - Hydrofluoric Acid Tank Area - Building 714

IHSS 139.2 is related to two horizontal, 1,300-pound, hydrofluoric acid (HF) cylinders, each with a 1,200-pound capacity (Appendix B), which are located in Building 714, a small shed approximately 4 feet east and 29 feet south of the southeastern corner of Building 771 (Figure

2-11) The HF is delivered to the RFP in portable cylinders, which are replaced when empty. No open transfer of the acid takes place (EG&G, 1990c) The acid is piped to, and used in, Building 771 (Appendix B)

Discussions in previous reports for this IHSS indicate the shed contains two 1,200-gallon aboveground HF tanks This, however, is not the case. The HF is contained in two 1,300-pound cylinders

A portable, refillable nitric acid dumpster is located just north and west (approximately 25 feet) of the HF storage area discussed above More precisely, the dumpster is located at the southeast corner of Building 771 Although this is not part of an OU8 IHSS, nor is it identified as a PAC, investigations are planned for this area. Initial studies will include a ten foot area around the dumpster.

This dumpster supplies nitric acid to the Building 771 chemical makeup area. The acid is delivered to the 218 tank farm near Building 444 by an outside supplier One of two available dumpsters is picked up at Building 771, taken to the bulk supply, and filled by Building 774 Chemical Operators. The dumpster is then returned to Building 771 This activity occurred on a daily basis while Building 771 was operational as a plutonium recovery facility (Appendix B).

IHSS 139.2 was originally defined as a 40- by 60-foot area that encompasses the HF shed (Building 714) south of Building 771 (EG&G, 1990c) The information compiled on IHSS 139.2 for the HRR indicated that the location presented in the IAG was inaccurate. For this Work Plan, it is proposed that the location of IHSS 139.2 be redefined to represent the location of the HF storage shed, Building 714. This is approximately 350 feet south and 250 feet west of the location presented in the IAG as IHSS 139.2 (DOE, 1992a) More recent information presented by Doty & Associates (Appendix B), indicates that IHSS 139.2 be located approximately 45 feet south of the southeast corner of Building 771 and that its boundaries be reduced to approximately

25 by 35 feet (Figure 2-11) The area is flat, includes both paved and unpaved surfaces, and is heavily used. A large aboveground KOH storage tank is immediately east of the site (EG&G, 1990c)

2.3.9 IHSS 144 - Sewer Line Breaks - near Building 730, Tanks 776 A-D, (IAG Name: Sewer Line Break)

IHSS 144 is related to sewer line breaks associated with four underground waste holding tanks located north of Building 776 and east of Building 701 in a small structure identified as Building 730. They are designated as Tanks 776 A through D They were built in approximately 1956 (Rockwell, 1976) and were taken out of service in the 1980s. They are now used as plenum deluge tanks (Appendix B). Therefore, the tanks would normally be expected to be dry

RFP engineering drawings, specifically D-13493 and 28714-X51, provide additional information about these tanks The tanks are underground concrete tanks which are beneath a pumphouse. To gain access to the pumphouse, one must go through a ground-level doorway and descend 9.67 feet down stairs. At this level, one is essentially standing on the tanks, which have manhole covers (Appendix B).

The top of the pumphouse, which is slightly above the ground surface, is at an elevation of 5,988 0 feet MSL The floor of the pumphouse, also the roof of the tanks, is at an elevation of 5,978.33 feet MSL The base of the tanks are approximately 12 feet below the floor of the pumphouse, indicating an approximate base elevation of 5,966.33 feet MSL The concrete surrounding the pumphouse and tanks is approximately 1 foot thick (Appendix B).

The tanks are concrete and are not accessible for inspection. The capacity of Tanks 776 A and B are 22,500 gallons each, and the capacity of Tanks 776 C and D are 4,500 gallons each. The dimensions of 776 A and B have been reported to be 25'x15'x10' each, and those of 776 C and

D are 5'x15'x10' each (Rockwell, 1976) Tanks 776 A and B are laundry waste holding tanks, and Tanks 776 C and D are process waste holding tanks. Their design is such that if tanks C and D overflowed, the excess liquid could drain into tanks A and B, and vice versa (Appendix B)

From approximately 1969 until 1973, laundry waste could be transferred through the sewer lines to the sanitary sewer system 3004(U) A pipe header at the tanks allowed alternatives of pumping the laundry water to the sanitary sewer system, the Solar Evaporation Ponds, or Building 774 (Appendix B)

On approximately June 1, 1972, a revision of a Building 776 radiography vault floor drain was completed. Apparently, previous transfers of laundry wastewater from Tanks 776 A and B resulted in backflow into the vault. The revision to the floor drain, involving relocation of the drain pipe connection, would allow the waste to be transferred at higher pressures (Appendix B). On June 7 or 8, 1972, the increased pumping caused a toilet and sink in Building 701 to overflow and a patch to rupture in the line east of the waste holding tanks (Appendix B).

IHSS 144 was originally defined as a 20- by 50-foot area between Building 777 and 779 (EG&G, 1990c) It was proposed that the location of IHSS 144 be redefined to include the location of the clean-out plug overflow east of Building 730 (DOE, 1992b). More recent information provided by Doty & Associates (Appendix B), indicates that IHSS 144 should be divided into two separate sites, 144(N) and 144(S) IHSS 144(N) has dimensions of 25 by 70 feet and be located east of Building 701 (Figure 2-12). Since the exact location of the sewer line break between Buildings 777 and 779 is unknown, the boundaries of 144(S) will include more of the alleyway and is expanded to 15 by 170 feet (Figure 2-13).

The area between Buildings 777 and 779 is a narrow, paved alley which slopes down from the north to a level several feet lower than the surrounding ground, giving the appearance that it was excavated. The alley has been paved since 1968, and has sloped to the south since the two buildings were constructed (EG&G, 1990c).

2.3 10 IHSS 150 1 - Radioactive Site North of Building 771

This IHSS consists of an area north of Building 771 affected by radioactive leaks (Figure 2-14). Wastes from Building 771 and materials to be reprocessed in Building 771 were frequently handled and stored in the area north of the building Building 770, located north of Building 771, was built in 1965 and has been used as a residue storage area in the past.

From approximately 1962 until approximately 1968, a 5,000-gallon stainless-steel tank was located approximately 30 feet north of Building 771. The tank was on six-foot legs and was approximately 8 feet in diameter. Two overhead pipes from Room 114 in Building 771 connected to the tank, one of which was a vacuum vent to control transfer in and out of the other The tank was used in the Filtrate Recovery Ion Exchange system, which concentrated plutonium and americium for recovery. Americium was concentrated on an ion exchange column and was transferred at a predetermined concentration to the tank.

The tank was taken out of service following the discovery of a leak and was eventually disposed of at a DOE facility in Idaho (Appendix B).

The paved area between Buildings 771 and 770 was used for the storage of residue in drums prior to processing in Building 771. A June 1969 photograph shows over one hundred drums stored in rows on the pavement. A fence parallel to Building 771 also encloses the west entrance to Building 770 and defines a storage area. During the period that the area was used for storage, the paved area also functioned as the access road for Buildings 771 and 774 Drums were also stored in the courtyard south of Building 770 between the access road and the building This location has since been altered. The material stored consisted primarily of residues which had a high plutonium content and were destined for plutonium recovery operations in Building 771 Materials were stored in drums, on pallets, or in cargo containers In the 1960s, there was a concrete embankment wall along the southern and eastern sides of the courtyard, there is currently no embankment wall. Construction changes in this area are not clear. More information may be found at a future date regarding the physical alteration of the area. Drums of waste from the 1969 fire in Building 776 were stored in the area for inventory prior to relocation (Appendix B).

Due to environmental concerns related to the clean-up activities at the 903 storage area and the triangle storage area, site-wide efforts were made in the early 1970s to move all radioactively contaminated materials to indoor storage. The Building 771 area was used for storage until approximately 1974 when Building 776 was used for indoor storage. Building 770 was then used for the storage of equipment and also as an equipment assembly facility prior to the installation in other buildings (Appendix B).

IHSS 150 1 was originally defined as a 50- by 450-foot area north of Building 771 (EG&G, 1990c). Information developed on this IHSS from the HRR indicated that the waste storage and handling also occurred west of Building 770 and possibly north of Building 774 Due to the leaking tank incident in June 1968, it was proposed that the IHSS boundaries presented in the IAG be extended to the east approximately 120 feet. In addition, photographs clearly show that in March 1974, over 30 cargo containers were present immediately west of Building 770. The photographs also include close-up shots of the containers and the ground. This area was not within the original IHSS boundaries. Thus, it was proposed to extend the boundaries of IHSS 150.1 to include the area west of Building 770 (DOE, 1992b). Recent information provided by Doty & Associates (Appendix B), indicate the IHSS boundaries should be revised to approximately 60 by 360 feet (Figure 2-14).

The area encompassing this IHSS is paved, occupied by numerous trailers, auxiliary buildings and storage areas. The surface was repaved 4 to 5 years ago. Prior to this the asphalt was badly deteriorated, with soil exposed in many areas (EG&G, 1990c). The soil beneath the pavement is expected to be compacted fill because the area had been a fairly steep hillside sloping to the north before the area was levelled and buildings erected. The thickness of the compacted fill material is expected to vary across the site and increase to the north.

A small prefabricated building used for storage is located west of Building 770. This building was present in 1969 photographs and has been used for equipment storage.

Surface water on the pavement generally drains to the west. Prior to the mid-1960s, some surface runoff was able to drain into a strip of grass west of Building 770 between the access road and the Building 771 parking lot. The grass strip was reduced in width in the late 1960s and finally was paved entirely The area immediately north of Building 770 has a grated collection channel which directs collected surface water to the east toward a small pond ("Bowman's Pond"). The water in the pond is collected in the Interceptor Trench Pump House system associated with the solar ponds (Appendix B)

Several test wells were drilled in the area north of Building 771 in 1962 in preparation for the construction of an addition. One boring was located in the northeastern corner of Building 771 and was drilled to a depth of 36 feet from an elevation of 5,946 feet MSL. Fill existed to a depth of 1 foot, highly weathered claystone to a depth of 15 feet, and weathered claystone to the bottom of the hole. The water table was encountered at 6 feet, although the date of the borings was not provided (Appendix B).

2 3.11 IHSS 150.2 - Radioactive Site West of Buildings 771 and 776

IHSS 150.2 is related to the area west of Buildings 771 and 776 which were contaminated as a result of the September 11, 1957 fire in Building 771 and the May 11, 1969 fire in Building 776/777 Specific details on firefighting techniques could not be determined for the 1957 fire. However, water was used to suppress the 1969 fire. The west side of Building 771 was contaminated as a result of the 1957 fire Although no documentation was found which details specific activities in the area, a review of documents pertaining to the fire indicates that the west side of Building 771 was used extensively for staging of firefighting vehicles during the fire. The portion of the building that was most affected by the fire was Room 180, which is located in the southwest corner of Building 771; therefore, the west entrance provided good access for the firefighters At the time of the fire, there was an access door on the west side of the building and the area was paved (Appendix B) Currently, there is a loading dock located at the access door

In 1969, the west dock area of Building 776 was contaminated by tracking of radioactive materials by firefighting personnel. The contaminated area extended out from the building approximately 30 feet. Following the fire, rain transported contamination into nearby soil. Oil and gravel were placed on the soil to stabilize the contamination. The soil, oil, and gravel were removed on July 19, 1969 (Appendix B). Contaminated material was buried east of Building 881 (IHSS 130).

The IAG and the First Draft Work Plan (EG&G, 1990c) defined the IHSS 150.2 boundaries as a 70- by 250-foot area west of Building 771. Subsequently, information developed for the final HRR (DOE, 1992b) indicated that the location for IHSS 150.2 presented in the IAG is inaccurate and proposed that the IHSS be redefined as a 75- by 600-foot area west of Buildings 776 and 771 Information presented by Doty & Associates (Appendix B) subsequent to the HRR indicated that the boundaries of IHSS 150 2 should be expanded to 680 feet long along the west sides of Buildings 778, 776, and 771 and the width of this IHSS should range from approximately 70 to 90 feet. Supplemental information also developed by Doty & Associates (Appendix B) indicates that IHSS 150.2 should be divided into 2 separate areas (Figure 2-15) The northernmost area is located adjacent to the western side of Building 771. The southern most area is located adjacent to the western side of Building 776 and extends south to the northern side of Building 778

The ground surface west of Building 771 steps down steeply to the north, with numerous retaining walls, paved and unpaved storage pads, and loading docks. The storage areas hold drums, electrical equipment, and sheds. The surface, west of Building 776, is relatively flat and mostly paved The area was first paved in 1968 (EG&G, 1990c).

2.3.12 IHSS 150.3 - Radioactive Site Between Buildings 771 and 774

A tunnel between Buildings 771 and 774 was built during construction of the buildings in 1952. The tunnel was originally built as an exhaust ventilation duct for Building 774 and contains process waste lines This IHSS consists of an area between Buildings 771 and 774 that was contaminated by a radioactive leak from the process waste lines in 1971 and by an unspecified amount of aqueous process waste released from a separated flange in the late 1970s or early 1980s Personnel recalled that the area was cleaned up (DOE, 1992b).

The interior of the tunnel is 3 4 feet square. It is constructed of 8-inch-thick removable concrete slabs with a copper water seal at the joints. The tunnel is approximately 175 feet in length and slopes evenly from the east side of Building 771, where the tunnel has an interior floor elevation of 5,963 feet MSL, to the west side of Building 774, where the tunnel has an interior floor elevation of 5,939 66 feet MSL. The tunnel has a periscope-type shape on the west end where it raises sharply and enters Building 771 at an elevation of 5,974.7 feet MSL (Appendix B). The tunnel also "doglegs," running east/west on the west end of the tunnel, and then angling to the northeast near the east end of the tunnel

IHSS 150 3 was originally defined as a 100- by 140-foot area east of Building 771 (EG&G, 1990c). More recent information provided by Doty & Associates (Appendix B) indicates the boundaries of this IHSS should be changed to approximately 155 by 25 feet with the east end extending up to the southwest corner of Building 774 to include an area surrounding the entire tunnel (Figure 2-16).

The land surface above the tunnel has been modified as a result of construction and slope stabilization activities over the years When the tunnel was originally built, the ground surface to the north of the tunnel was relatively flat as compared to the present topography, currently, the ground surface slopes steeply to the north descending into the 771/774 courtyard. As a result, the tunnel now is partially exposed; a walkway has been erected on the top of the tunnel adjacent to Building 774 It should also be noted that there are overhead pipes in the 771/774 courtyard (Appendix B). South of the IHSS the area is relatively flat and mostly paved, while the north side slopes steeply to the north into an unpaved courtyard between Buildings 771 and 774.

2 3.13 IHSS 150.4 - Radioactive Site East of Building 750

IHSS 150 4 was believed to have been contaminated due to tank and pump equipment decontamination activities following the May 1969 fire in Building 776/777 and/or from "leaking manholes" in the area (Appendix B). No documentation has been found which confirms the staging of decontamination equipment near Building 750 Present and former RFP employees did not recall the use of the area for such activities. No documentation regarding "leaking manholes" was found; however, the leak refereed to may be related to the high levels of gross Alpha and Beta radiation detected in a sump located just outside Door 3, South of Building 778

Investigation into the high levels resulted in finding a leaking process waste line located above the sump

IHSS 150 4 was originally defined as a 120- by 180-foot area northeast of Building 750 (EG&G, 1990c) According to the HRR, it was proposed that the location of IHSS 150 4 be redefined as an area to the northwest of Building 750 (DOE, 1992b). More recent information provided by Doty & Associates (Appendix B) indicate that IHSS 150 4 is located in the courtyard of Building 750 which is between Buildings 707 and 750 and should include only an area in which the process waste leak occurred. Thus, dimensions of this IHSS are approximately 20 by 20 feet (Figure 2-17)

The surface in this area is flat, mostly paved, and used for storage, parking, and loading/unloading for Building 750. The area has been paved since construction of Building 750 in 1969

2.3.14 IHSS 150.5 - Radioactive Site West of Building 707

Recent information obtained by Doty & Associates (Appendix B, May 28,1992) indicates that IHSS 150 5 is actually the same as IHSS 123.2. Additionally, the leading agencies (CDH, 1992) have transferred IHSS 123.2 to OU9. Therefore, IHSS 150.5, as with IHSS 123.2, has not been addressed in the OU8 Work Plan.

2.3 15 IHSS 150.6 - Radioactive Site South of Building 779

On June 22, 1969, an empty drum with residual contaminated oil was cut apart near a dock at Building 779 (DOE, 1992b and Appendix B) and was spread by pedestrian tracking. Contaminated oil was tracked across the first floor, the dock, and surrounding outdoor areas south and east of Building 779 (Appendix B) The main dock for Building 779 is located along the northern half of the east side of the building Although, the exact pathway along which workers walked is unknown, it is known that the buildings south entrance was also contaminated Therefore, it is unclear whether workers got from the dock to the south entrance of the building by walking inside the building, or outside and around the building. In order to plan a conservative yet thorough investigation plan, the roadway from the cooling towers and dock to the south entrance is considered to have been the path traveled by the workers.

No incident report for this event was found. It is likely that one was not written due to the attention demanded by the May 11, 1969 fire in Buildings 776 and 777 and subsequent cleanup activities. However, other sources indicate that following a release in 1969, an unknown number of drums of soil were removed for off-site disposal (EG&G, 1990c). It is not known whether all areas affected by this incident were included in cleanup activities (DOE, 1992b).

IHSS 150 6 was originally described as a 100- by 200-foot area south of Building 779 (EG&G, 1990c). According to the IAG, the dimensions of this IHSS are approximately 185 by 50 feet. The IAG also indicates the location of this IHSS to be south of Building 779 and encompassing the northern portions of Buildings 705 and 706. Recent work by Doty & Associates (Appendix B) indicates that the area should include both the eastern and southern sides of Building 779 and extend approximately 40 feet south of Building 779 to the north side of Tank T779A but should not encompass the northern portion of Buildings 705 and 706. Also, Doty & Associates' work indicates that IHSSs 150.6 and 150.8 should be combined because of the continuous nature of the incident which caused them to be listed as IHSSs.

The surface in this area is currently relatively flat and mostly paved (Figures 2-18 and 2-19). The area is heavily used by pedestrian traffic Several overhead pipes serving Building 779 extend over the area, and a permanent trailer (T779A) is also present (EG&G, 1990c).

2.3.16 IHSS 150.7 - Radioactive Site South of Building 776

This site, as with other IHSS 150 sites, was contaminated by the May 1969 fire which occurred in buildings 776/777 which are to the north of this site (Figure 2-20). Following the fire, rain carried contamination into the soil. Airborne contamination from this incident was carried predominately to the west-southwest, the average wind direction at the time. The area west of the building is included in IHSS 150.2, which pertains to contamination resulting from the 1957 and 1969 fires.

IHSS 150.7 was originally defined as a 100- by 500-foot area between Buildings 776 and 707 It was proposed that IHSS 150.7 be redefined as a 40- by 350-foot area between Buildings 776 and 778 due to the contamination resulting from the May 1969 fire in Building 776/777 (EG&G, 1990c). Doty & Associates (Appendix B) provided updated information in June of 1992 that indicated the boundaries of this IHSS to be approximately 40 by 330 feet. Additional site research performed by Doty & Associates (Appendix B) states that maps showing the area of contamination, produced during and after cleanup activities, indicate that the affected area extended to the north wall of Building 707. The boundaries of this IHSS now encompass the area indicated on Figure 2-20 as being potentially contaminated. Very narrow, flat "courtyards" separate Building 778 from Building 707 on the south and from Building 776 on the north. These courtyards are isolated by enclosed hallways between the buildings (EG&G, 1990c).

An asphalt roadway was completed in the area on July 22, 1969 (DOE, 1992b). Much of the area between Buildings 776 and 778 is unpaved and inaccessible to vehicles, and is used for light storage and by pedestrians (EG&G, 1990c).

2.3.17 IHSS 150 8 - Radioactive Site Northeast of Building 779

This IHSS consists of an area east of Building 779 across which contaminated oil was tracked over the first floor, dock, and surrounding outdoor areas south and east of Building 779 (Appendix B) IHSS 150.8 has been previously defined as an 80- by 120-foot area east of Building 779 (Rockwell, 1986f). Doty & Associates have provided information (Appendix B) that indicates that this IHSS is the same as IHSS 150.6 and consequently have been combined The reader is referred to Section 2.3.15 for description of the current conditions of IHSS 150.6

2 3.18 IHSS 151 - Fuel Oil Leak - Tank 262 North of Building 374

IHSS 151 is related to spills of No. 2 diesel fuel oil from an underground storage tank north of Building 374 Infrequent spills have occurred since August 12, 1981 and have involved up to 196 gallons of diesel fuel IHSS 151 was originally defined as a 30- by 35-foot area centered over Tank 262 north of Building 374 (DOE, 1992a and 1992b). Doty & Associates have provided updated information (Appendix B) that indicates the boundaries of this IHSS are approximately 45 by 60 feet (Figure 2-21)

Tank 262 is a steel, 47,500-gallon, underground storage tank installed in 1980. It is overlain by a 15- by 25-foot concrete pad containing control valves and gauges (DOE, 1992b). The surface around the pad is flat and unpaved (DOE, 1992)

2 3 19 IHSS 163.1 - Radioactive Site North of Building 774

CEARP interviewees recalled that an area north of Building 774 was used for washing equipment and vehicles that were contaminated with unspecified types of radioactive materials. This area has been identified as IHSS 163.1. Operationally, personnel would use nitric acid, soap, and water for the cleaning, and the solution would flow onto the ground (Appendix B). Building 774 personnel did not recall this area ever being used to wash equipment or vehicles (DOE, 1992b) A former RFP employee contacted in August 1992 recalled that cleanup of trucks occurred near the dock at the northeast corner of the building (Appendix B).

According to Doty & Associates (Appendix B), it has always been an RFP policy that extreme care be exercised for the protection of the workers and of the environment. An event that would have released radioactively contaminated liquid onto the ground and allowed to runoff into the surrounding environment is not consistent with this policy. It was the purpose of the RFP Site Survey Group to monitor outdoor activities and events for the presence of radionuclides. Interviews were held with two retired Site Survey monitors who were with the RFP from the 1950s until the 1980s. These individuals would have been aware of radioactively contaminated vehicles and equipment being decontaminated outside of buildings. They could not recall any activity similar to this description having happened and could not believe that it could have without their knowledge Furthermore, on occasion, when a vehicle became contaminated, it was either decontaminated at the location of the incident to reduce the potential for contamination spread or, if safe, it was taken to a suitable on-site location for decontamination Building 774 may have been suitable for the decontamination of some equipment because of the accessibility of the docks Decontamination of vehicles was performed by wiping the surfaces with kimwipes and then monitoring until the surface was clean The vehicle was not cleaned by being hosed down There was no resulting wash water which could penetrate the asphalt or soil. The area around the decontamination site was monitored afterward and cleaned up if contamination was detected

The results of the Radiometric Survey, performed at the RFP during the late 1970s and early 1980s, indicated no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) northeast of Building 774 (Appendix B) No radioactivity above background levels was indicated at this location by the surveys conducted from 1977 through 1984 (DOE, 1992b)

Aerial photographs taken from 1969 and 1971 show two areas east of this IHSS that were covered with mounds of soil RFP personnel interviewed did not recall these mounds. The mounds are believed to be unrelated to IHSS 163.1 (EG&G, 1990c and 1992b).

IHSS 163 1 was originally defined as a 60- by 150-foot area northwest of Building 774 (EG&G, 1990c) Based on the evaluation of all available information concerning this IHSS, the boundary is shown to be approximately 50 by 125 feet, as depicted in Figure 2-22.

The eastern half of the area is mostly flat and paved and is covered in part by trailer T771G The area was repaved 4 or 5 years ago. The western half is unpaved, slopes to the north, and is crossed by an unpaved access road for the solar evaporation ponds (EG&G, 1990c).

2.3.20 IHSS 163.2 - Radioactive Site North of Buildings 771 and 774

Information for the development of the following discussion of IHSS 163.2 was gathered from the review of documents, historical drawings, and historical engineering drawings as well as interviews with Building 771 employees. The information identified for this OU Work Plan found inconsistencies with the discussion presented in RCRA 3004(u) (Rockwell, 1986f).

An americium-contaminated slab is reported to be buried in the area near Building T771A by the Perimeter Road. The slab is reported to be approximately 8 feet square and 10 inches thick. From approximately 1962 until approximately 1968, the slab served as a foundation for a 5,000-gallon stainless steel tank located approximately 30 feet north of Building 771. The tank was used in the Filtrate Recovery Ion Exchange system which concentrated plutonium and americium for recovery. Americium was concentrated on an ion exchange column and was transferred at a predetermined concentration to the tank.

Around 1968, the tank was temporarily sealed following the discovery of a leak. Once emptied, the tank was taken out of service The tank remained in place until it was taken to the size-reduction facility in Building 776 sometime shortly thereafter When the tank was removed to the size-reduction facility, the concrete slab was decontaminated. The slab was moved to a ditch directly north of the area and buried. The area was paved sometime prior to June 1969 In the mid-1970s, Building T771A, a prefabricated structure, was constructed in the same general area. None of the persons interviewed for this investigation recalled any subsequent excavation of the slab (Appendix B) The slab lies underground near or beneath the east end of T771A at a probable depth of less than 10 feet.

An environmental summary report from 1973 does not record the incident in the summary of environmental incidents impacting the soil at the RFP, however, the report does have a notation of the slab on a map of the area north of Building 771. The report indicates that prior to 1973, an area farther to the north of where the slab is believed to be buried and states that it was later excavated and the contaminated portion cut away for off-site disposal (DOE, 1992b). This is not believed to be the case, because the location indicated on the map cannot be accurate as area that was paved several years before the slab became contaminated. As stated above, there has been no verification that the slab was subsequently excavated (DOE, 1992b).

The 8- by 8-foot slab is probably still buried beneath the pavement near Building T771A. There was no mention of americium-contaminated soil being buried with the slab. However, because the slab had been located on soil, it is likely that some soil from beneath the slab was also deposited when the slab was pushed into the ditch. However, it is not likely that there is a significant amount of contaminated soil surrounding the slab. Other material of an unknown source was backfilled into the ditch prior to the area being graded and paved (Appendix B).

The ditch the slab was buried in a surface drainage formerly directed to the west into a tributary to North Walnut Creek. It is not known how long the slab remained in the ditch before the area was paved (Appendix B).

IHSS 163.2 was originally defined as a 50- by 50-foot area north of Buildings 771 and 774, outside the Protected Area just southeast of Parking Area No. 71 (EG&G, 1990c). Recent information provided by Doty & Associates (Appendix B) indicates that IHSS 163.2 is an area approximately 60 by 40 feet near the east end of T7711A (Figure 2-23).

The area is on a steep north-sloping hillside into the North Walnut Creek drainage The Building 771 parking lot is over approximately 40 feet of fill material right in the drainage. Building 771 was built into the hillside with the roof of the two-story building at ground level along the south wall. The location of the slab is in an area of varying depths of fill over weathered clay bedrock (Appendix B)

2.3 21 IHSS 172 - Central Avenue Waste Spill

IHSS 172 follows the path formerly used by vehicles to transport drums of waste between the 903 Pad, where the drums were stored, and the waste treatment facility in Building 771. It spans a distance of approximately 1 mile, crossing the Protected Area southeast of Building 374, and includes· the westbound lane(s) of Central Avenue between the 903 Pad and Sixth Street; the northbound lane(s) of Sixth Street between Central Avenue and the northwestern corner of Building 771, and the dock area, still in use, at the northwestern corner of Building 771 (EG&G, 1990c).

In June 1968, according to reference documents, one or two drums containing plutonium-tainted oil and oils with lathe coolant leaked along this path while in transit. Only the northbound and westbound lanes reportedly were affected. A former Rockwell employee recalled a number of details about this incident. The leak occurred near the end of the work day. A forklift was dispatched to transport several drums of contaminated lathe coolant on a pallet from the 903 Pad to Building 771 The drums generally were transported by truck. However, these three drums represented some of the last remaining drums at the 903 Pad, and the small load may not have warranted a truck. Only one of the three drums leaked, and the drum released only a small portion of its contents, suggesting that the spill involved perhaps 10 gallons or less The leak resulted from sloshing of the drum contents through an improperly sealed bung during transport. Because of this, no more material was likely to have spilled at stopping points than at other points along the route. The spill was detected when the forklift reached Building 771, and the affected roadway was quickly cordoned off An effort was made to clean up the spill, and the roadway was seal-coated before being reopened to RFP traffic (DOE, 1992, 1992a, and EG&G, 1990c).

Also an unknown amount of "low-level material" reportedly spread to the ditch along the north side of Central Avenue as a result of this spill. Aerial photographs taken in 1969 of RFP show that this ditch ran along essentially the entire affected length of Central Avenue. Most of the ditch has since been paved over, lined with concrete, or filled in by subsequent construction. Available references do not indicate what area(s) of the ditch received contamination. Because the release was relatively small and the cleanup response was very timely, significant contamination of the ditch is not expected (EG&G, 1990c).

Most of the affected roadway has since been repaved and remains heavily used A section of Central Avenue between Eighth and Tenth Streets was removed in August 1970 and placed in an asphalt dumping area east of Building 881 (IHSS 130). The section of Sixth Street between Sage Avenue (outside the Protected Area) and the perimeter road within the Protected Area was removed during Protected Area construction between late 1980 and late 1982. The fate of the removed asphalt is not known (EG&G, 1990c).

Because of the small quantities of material believed to have been released during the incidents described above, the cleanup efforts undertaken at the time of these incidents, and disturbance of the areas affected by construction activities and paving, it is recommended that IHSS 172 be redefined to exclude those portions of the roadway subsequently removed These include Central Avenue between Eighth and Tenth Streets (approximately 1,050 linear feet) (DOE, 1992a) and Sixth Street between Sage Avenue and the Protected Area perimeter road (approximately 320 linear feet) (EG&G, 1990c).

2.3.22 IHSS 173 - Radioactive Site - 900 Area (Storage Vaults near Building 991)

This IHSS (Figure 2-25) is associated with storage near Building 991. It originally encompassed Building 991 and associated underground storage vaults (or tunnels) 996, 997, 998, and 999 (these original plant structures have been in operation since 1952) The area lies within the South Walnut Creek drainage, primarily on the south-sloping north side of the drainage (EG&G, 1990c) The south dock of Building 991 is located on the west side of the building and is a loading facility for the tunnels. Small parts and equipment were washed in the dock area. Final products containing plutonium and uranium were shipped from the dock, but no raw products were involved in the operations ongoing within Building 991 Acetone, perchloroethene, and trichloroethane were solvents used within the building (DOE, 1992a).

Building 991 was the first active building at the RFP and was used for storage and loading/unloading of finished products. According to former RFP employees, the "south Dock" is actually located on the west side of Building 991, and is referred to as "south" because it is located south of the tunnels to Buildings 996 through 999, to and from which loading/unloading operations were being conducted. According to former RFP employees, the dock and courtyard were often washed down with water, which could seep into cracks and the edge of the asphalt (Appendix B).

Cleaning of depleted uranium parts was conducted in the courtyard of Building 991, which is located on the west side of the building near the dock, in the late 1950s and early 1960s Acetone and solvents were used for cleaning of parts and the spent cleaning solutions were stored in drums and removed for disposal. Spills and water could have drained into storm drains. These washing activities were conducted along the north wall of the asphalted courtyard (Appendix B).

The storage vaults and tunnels associated with Building 991, Buildings 996 through 999, are used for storing finished uranium, plutonium, and beryllium parts prior to off-site shipment. The finished product was not considered radioactive because the components were plated with nickel. The vaults have reportedly been subject to infiltration of groundwater. The structural integrity of the vaults was compromised during construction of Building 771, due to heavy equipment driving over the area. According to newspaper articles, water is entering the tunnels through fractures in the walls, ceiling, and floors (Appendix B).

Results of a Radiometric Survey, performed at the RFP during the late 1970s and early 1980s, indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) around the south dock of Building 991 (Appendix B). According to CEARP Phase I, routine surveys of the vaults have indicated that they are free of radioactive contamination, with the exception of tunnel 996 which might be slightly uranium infiltrated. Final products containing plutonium and uranium were shipped from the dock (DOE, 1992a).

Information developed on the unit for this study indicates that the location of IHSS 173 presented in the IAG is inaccurate. The IAG indicates the entire building and the area over the tunnels and vaults should be included in the IHSS primarily because of the age of the structures. Even though there was no documentation found indicating potential for contamination of the area, it is believed from interviews with retired RFP personnel involved with the activities of this area that the south dock would have a greater probability than the building or vaults of being potentially contaminated The south half of the building was used for offices and the north half for laboratories and research

The IAG boundary for this IHSS includes all of Building 991 and its surrounding areas. Contaminated area underlying and surrounding the vaults and tunnels of Building 991, as well as the building itself, will be remediated as Under Building Contamination (UBC) 991 as indicated in the final Historical Release Report of June 1992; therefore, it is proposed that this IHSS includes only the dock area. This proposal was made in the HRR (DOE, 1992a) and accepted by the regulatory agencies (Appendix B)

The surface around Building 991 is paved, receives moderate to heavy traffic, and is enclosed by a security fence. This area has been paved for over 20 years; the pavement has been disrupted at times by construction and was extended to encompass Building 984, just south of 991, which was built in the 1980s.

2.3 23 IHSS 184 - Radioactive Site - Building 991 Steam Cleaning Area (near Building 992)

The Final HRR report states that an area southwest of Building 991, near Building 992, was used between 1953 and 1978 to steam clean radioactively-contaminated equipment and drums. The rinse water was collected in a sump for treatment in the RFP's process waste system (DOE, 1992b) Building 991 personnel indicated that steam cleaning was done in an area within the southwest corner of the Building 991, not beside the guard shack or elsewhere outside the building. This was discontinued around 1969 when new cleaning facilities became available. The area was used to clean stainless-steel containers needed to ship materials to other U.S. AEC (now DOE) facilities. Although these containers were returned empty to Building 991 by the other facilities and were steam cleaned prior to reuse. It was reported in CEARP Phase 1 that some of the equipment may have been radioactively contaminated. The cleaning was done on a concrete floor which is still in place Wash water ran into an outside drain which flowed south and east beneath pavement before emptying into an unlined ditch just southeast of the building. Although not included within this IHSS, the 400 lineal feet downstream (east of the IHSS) will be investigated utilizing radiation surveys and possible sediment sampling The drain system is also still in place (EG&G, 1990c)

CEARP interviewees recalled that there was a small contaminated sot on the ground that was cleaned up (Appendix B). Approximately 3 feet were excavated during cleanup. It was stated that this occurred on the north side of Central Avenue, southwest of Building 991; however, the exact location was not stated Many spots of contamination had been detected in the past in soil along Central Avenue in this area due to the presence of the Mound, Trench No. 1, and Oil Burn Pit No 2 It is unlikely that the 3 feet of contaminated soil was associated with the steam cleaning activities Building 991 personnel indicated that steam cleaning was discontinued prior to the aerial photo dated 1971 (EG&G, 1990c).

IHSS 184 was originally defined as a 50- by 50-foot area near Building 992, just southwest of Building 991 (EG&G, 1990c). Information provided by Doty & Associates in June 1992 (Appendix B), indicate that the boundaries of this IHSS are approximately 55 by 75 feet located south of Building 991 According to Doty & Associates more recent work, August 31, 1992 (Appendix B), no documentation exists that delineates the location of washing activities; however, the paved area between Building 992 and the south dock may have been used for steam cleaning. Therefore, it is proposed to extend the IHSS boundaries to include the paved area (Figure 2-25)

2 3.24 IHSS 188 - Acid Leak (Southeast of Building 374)

This IHSS is related to a 1983 incident recalled by CEARP interviewees in which a 55-gallon drum containing nitric and hydrochloric acid leaked near the east gate of Building 374 (DOE, 1992a) It is likely that the mixture was a waste metal leaching solution originating from the 400

Area which suggest that it might have contained some trace heavy metals. According to the CEARP Phase I Document, no environmental hazard should remain (DOE, 1992a).

There is a dock located in the southwest corner where Building 371 and Building 374 intersect. This is the area where this site should be located. Plate 2 (DOE, 1992a) reflects the change from the IAG map which had this site located south of Building 374. The dock normally handles drums of this type and contains a sump capable of handling a spill of this size; therefore, the spill must have occurred on the ground next to the building. The surface was flat and unpaved at the time of the acid leak and was later paved in the mid-1980s.

Recent investigations have found no documentation regarding the incident or cleanup activities. The incident is not mentioned in the "Summary of Events or Environmental Analysis Weekly Highlights" for the 1983 time frame. Additionally, there were no event-specific reports found which detail the incident. Employees who were in positions to have responded to such an incident do not recall this incident and state that they knew of no reason why a drum containing acids would have been in the area of Building 374 (Appendix B).

IHSS 188 was originally an area of unspecified size southeast of Building 374. HRR information indicates that the site should be closer to Building 371 and 374 than is indicated in the IAG (DOE, 1992b) The current location and dimensions (approximately 65 by 110 feet) are shown on Figure 2-26.

2 4 NATURE AND EXTENT OF CONTAMINATION

The description of the nature and extent of contamination presented in this subsection is based on historical reports, review of historical photographs, site visits, interviews with former and present RFP employees, and review of analytical data obtained from the Rocky Flats Environmental Database System (RFEDS) Appendix F contains all available analytical data for surficial materials (i e., artificial fill and alluvium), bedrock, and groundwater samples from wells and boreholes discussed in this subsection Analytical data from RFEDS for surface water and sediment samples from monitoring sites relevant to OU8 are presented in Appendix G Validated data are identified in the tables in these appendices and in the summary tables in this subsection by a V (validated and valid), an R (validated and rejected), or an A (validated and acceptable with qualifications) The designation J indicates that data are present but below the detection limit, and B indicates that the constituent was also detected in laboratory blanks. Validated data were validated according to the guidelines in Section 3 of the QAPjP

Analytical data from RFEDS for the area in and around OU8 are limited, and much of the analytical data have not been validated. The quality of the unvalidated data is unknown and is included here for planning purposes only. Without the unvalidated data, the amount of data available would not be sufficient for making initial decisions regarding the nature and extent of contamination or for determining the number and locations of sampling points for the RFI/RI.

As noted on the summary tables presented in this subsection, the concentration units indicated in RFEDS for several constituents appear to be incorrect. Where such discrepancies were apparent, the units reported are those indicated in RFEDS, but it is noted that the units appear to be incorrect. No attempt was made to resolve these apparent discrepancies during the preparation of this Work Plan.

Analytical data presented in this subsection are compared to background data to characterize the nature and extent of contamination. The background data discussed in this subsection are those provided in the Background Geochemical Characterization Report for 1989 (EG&G, 1990b). The Background Geochemical Characterization Report identifies separate environmental media, and through statistical analyses provides background concentrations for each media, or group of media. In that report, where sufficient data were available, tolerance intervals were calculated for each parameter. When there was an insufficient number of samples or an insufficient number of detectable concentrations for a given constituent for the calculation of tolerance intervals, the Background Geochemical Characterization Report provides the maximum detected value. The analytical data obtained for OU8 were compared to the upper tolerance limit (or both upper and lower tolerance limits for pH) or the maximum detected concentration for each parameter to determine if the concentration exceeded background In addition, when the upper tolerance limit was exceeded the concentrations were compared to the maximum concentration detected in background samples as an additional indicator of whether the concentration detected may be evidence of a release to the environment. When the pH of a sample was greater than the upper tolerance limit or less than the lower tolerance limit it was also compared to the range of background values.

Background data for media relevant to the discussion of the nature and extent of contamination associated with OU8 are summarized in Tables 2.3 to 2.6. For the purposes of this discussion, analytical data for surficial materials identified as artificial fill on borehole logs were compared to background data for North Rocky Flats Alluvium. Regardless of whether borehole logs identified bedrock as being weathered or not, all bedrock data were compared to the background concentrations for weathered bedrock.

2 4.1 Contamination in the Vicinity of IHSSs Within OU8

Subsections 2.4 1 1 through 2.4.1.24 discuss the nature and extent of contamination associated with each IHSS within OU8 These discussions are based primarily on the documented events related to each release within an IHSS and the available analytical data for borehole and groundwater samples Data on surface-water and sediment monitoring are generally not discussed on an IHSS-specific basis due to the fact that the monitoring locations for these media are such that contamination attributable to individual IHSSs cannot be defined. Summaries of the data available for these media are provided in Subsection 2.4.2.

The analytical data for wells that were completed as piezometers are limited to borehole samples taken when the wells were drilled. Figure 2-27 is a map of the wells and boreholes in the vicinity of OU8 showing those for which analytical data were requested from RFEDS and the types of data available for each well. The data available for each well discussed in the following subsections are included in Appendix F and are summarized in tables presented in the following subsections Each of the summary tables provides data for those constituents that were detected in concentrations exceeding background, and only above-background concentrations are provided for each constituent.

Groundwater data relevant to each IHSS were selected primarily based on the direction of groundwater flow indicated by the high and low water table maps in Figures 1-27 and 1-28. Control for the potentiometric surface shown in those maps is lacking in several locations because of the lack of water level measurements in those locations. In these instances, wells were also selected for this evaluation based on plausible alternative interpretations of the water table configuration in those locations.

It should be recognized that all of the conclusions in the following subsections are tenuous in that they are based upon data of insufficient quantity and quality. The wells and boreholes discussed in these subsections were not installed for the purpose of defining the nature and extent of contamination associated with the individual OU8 IHSSs. Thus, the wells and boreholes are not ideally located for such a purpose and are often not sampled for the constituents of interest to a particular IHSS. In addition, most of these wells and boreholes are located downgradient from more than one OU8 IHSS as well as other potential sources of contamination not addressed by this Work Plan.

2 4 1 1 IHSS 118.1 - Solvent Spills West of Building 730

Recent information indicates that IHSS 118.1, which consists of a 5,000-gallon underground carbon tetrachloride storage tank, is defined by a 30- by 13-foot area located adjacent to the east side of building 701 (Figure 2-3). In the 1970s, tank overflows of either trichloroethene (TCE) or carbon tetrachloride occurred during filling operations as discussed in Section 2.3.1 The practice at that time was to flush the affected areas with large volumes of water Additionally, what has been described as a "considerable" quantity of TCE and/or carbon tetrachloride leaked into the sump and was subsequently pumped out and onto the ground (DOE, 1992b)

In March of 1976, a small amount of leakage from the pipes in the tank pit was evident. During this time, Health Sciences was continuing monitoring for airborne carbon tetrachloride in a pipe installed beneath the end tank. Industrial Hygiene reported that March air samples were typically averaging 10 mg/l of carbon tetrachloride when in February 1976 they found no indications of problems with the tank itself. During the month prior to April 15, 1976, the average concentration rose to near 2,000 mg/l of carbon tetrachloride. It was speculated that the tank or its associated pipes in the sump could have been releasing the carbon tetrachloride into the ground (DOE, 1992b).

During these winter and spring months, there were documented efforts to stop the leakage from the pipes. Documentation was found which detailed the cleanup of spilled liquid, including that pumped onto the ground (Appendix B).

As stated in Subsection 2.3.1, on June 18, 1981, the tank failed, releasing carbon tetrachloride into the sump The sump subsequently pumped some of the liquid out onto the ground surface. Temporary storage tanks were to be obtained to collect the liquid. No documentation was found which details the actual use of temporary storage tanks. The tank was subsequently removed surficial materials in concentrations exceeding their respective upper tolerance limits, but none were detected in borehole samples in concentrations greater than maximum background concentrations. The only metal that exceeded background in samples of bedrock was arsenic. The concentrations of arsenic, however, did not exceed the maximum background concentration for weathered bedrock. Only one sample of surficial materials was analyzed for radionuclides The levels of gross alpha, radium-226, tritium, uranium-233,234, and uranium-238 in this sample exceeded background, but only gross alpha, tritium, and uranium-238 were detected in concentrations greater than maximum background concentrations for alluvium. Plutonium-239/240 and tritium were detected in concentrations exceeding background in all samples of bedrock from this well analyzed for these isotopes

Several VOCs were detected in samples of surficial materials and bedrock from well P209289. Benzene, chlorobenzene, methylene chloride, toluene, and TCE were detected in samples of both surficial materials and bedrock. Most of these compounds were detected in concentrations less than detection limits and laboratory blank contamination for these constituents was not indicated. With the exception of methylene chloride, the only samples of surficial materials that contained these compounds were those taken immediately above the alluvium-bedrock contact. Acetone, chloroform, and 1,1-dichloroethene (1,1-DCE) were also detected in samples of surficial materials Laboratory blank contamination for these constituents was not indicated Metals detected in concentrations greater than background were arsenic, barium, copper, manganese, and zinc in surficial materials, and arsenic, beryllium, iron, and zinc in bedrock. None of the concentrations of metals detected were greater than their respective maximum background concentrations. Americium-241, radium-226, tritium, uranium-233,234, and uranium-238 were detected in above-background concentrations in samples of surficial materials. The concentrations of americium-241 and tritium exceeded maximum background concentrations. Analysis of radionuclides was not performed on bedrock samples.

Groundwater samples from well P209189 have contained a number of VOCs including carbon tetrachloride, chloroform, 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,2-DCA), 1,1-DCE, 1,2-dichloroethene (1,2-DCE), perchloroethene (tetrachloroethene, PCE), and TCE. The concentrations of these compounds detected are generally less than method detection limits Many of these compounds, 1,1-DCA, 1,2-DCA, 1,1-DCE, and 1,2-DCE, are degradation products of PCE and TCE (Figure 2-28) Calcium and iron have been detected in concentrations exceeding background in groundwater from this well, however, the concentrations of calcium detected have all been less than the maximum background concentration. Magnesium was also detected at a concentration greater than background on one occasion. Americium-241, cesium-137, plutonium-239/240, radium-226, and tritium have been detected in groundwater samples in concentrations exceeding background. Cesium-137 and radium-226 concentrations have exceeded background only once each. Bromomethane and chloroform were detected in the one sample of groundwater from well P209289. This sample was not analyzed for metals or radionuclides.

Analytical data indicate that releases from IHSS 118.1 may have impacted groundwater. This conclusion is tenuous in that it is based upon data of limited quantity and quality. Data on soil and groundwater conditions at the IHSS site and immediately upgradient and downgradient from this IHSS are lacking and are needed in order to define the source of the contaminants detected in wells near the IHSS and to further define any possible hydraulic interconnection that may exist in this area. As discussed above, the data available for well P214689 is of limited use in establishing upgradient conditions at this time due to the considerable distance between this well and the IHSS and due to the lack of data for groundwater from this well. The data available for this well may be useful in future investigations when establishing upgradient conditions for this and other IHSSs

Borehole sample and groundwater data from wells P209189 and P209289 indicate that a wide variety of VOCs have impacted soils and groundwater in the vicinity of these wells. In addition to the detection of carbon tetrachloride, the detection of PCE, TCE, and a number of degradation products of these compounds in groundwater is notable. These data indicate that the possibility that TCE may have been released during the documented spill cannot be ruled out at this time. Several metals and radionuclides have been detected in concentrations exceeding background in borehole and groundwater samples from these wells. There is no history of the release of these types of materials from IHSS 118.1, but additional data are required to determine if the concentrations detected are indicative of contamination and the source(s) of such contamination.

2.4.1.2 IHSS 118.2 - Solvent Spill South End of Building 776

IHSS 118.2 is related to solvent spills from an above-ground carbon tetrachloride tank adjacent to the north side of Building 707 (Figure 2-4). As presented in Subsection 2.3.2, IHSS 118.2 has dimensions of approximately 30 feet by 20 feet.

Degreasing solvents which may have been stored in the organic solvent tank include carbon tetrachloride, petroleum distillates, benzene and dichloromethane paint thinner, 1,1,1-trichloroethane (TCA), and methyl ethyl ketone (MEK) (2-butanone) Solvent held in the carbon tetrachloride tank is used in Buildings 776 and 707.

In addition, leaks, spills, and overflows of unknown quantity have occurred from the tank during routine filling operations. Table 5 of the IAG indicates that elevated gamma radiation was detected at IHSS 118.2. This elevated level has been attributed to contamination from other nearby sources

No wells or boreholes are located in the immediate vicinity of this IHSS The nearest upgradient well is P214689 which is located approximately 900 feet southwest of the IHSS (Figure 2-27). As discussed in Subsection 2 4.1.1 for IHSS 118.1, the data available for well P214689 are of limited use at this time for defining the nature and extent of contamination associated with this IHSS due to the separation between the well and the IHSS and the lack of groundwater data for this well The nearest downgradient wells, 2386, completed in bedrock, and 2486, completed in alluvium, are located approximately 450 feet to the east-northeast (Figure 2-27). Groundwater samples from well 2386 have been collected quarterly since March 1987. A summary of the analytical data for these samples is presented in Table 2.10 The only analytical data available for well 2486 are the results of the analysis of VOCs and inorganic constituents in one groundwater sample collected on June 12, 1991. No VOCs were detected and nitrate/nitrite concentrations exceeded background in this sample.

The two wells downgradient of this IHSS provide some information on the hydrogeologic conditions that may exist at the IHSS The surficial materials are underlain by Arapahoe Formation claystones and silty claystones. There is 8.2 feet of gravel above bedrock in well 2386 and 7.2 feet of clayey gravel, caliche, and clay in well 2486. The surficial material is thin in both of these wells Well 2486, open to the surficial materials, is dry most of the time. Given the hydrogeologic conditions which may exist at the IHSS, it is not likely that a contaminant would have moved very far from the point of release. Solvents, such as DNAPLs, if they have been introduced to the groundwater, would most likely be found as isolated lenses in paleotopographic lows.

Carbon tetrachloride, methylene chloride, trans-1,2-dichloroethene (trans-1,2-DCE), and TCE have been detected in groundwater samples from well 2386. Carbon tetrachloride and TCE were detected in this well only one time each. Blank contamination with methylene chloride was indicated for one of the four samples that contained detectable concentrations of methylene chloride. Calcium concentrations in groundwater from this well routinely exceed the upper tolerance limit but do not exceed the maximum background concentration No radionuclides have been detected in concentrations greater than background in groundwater from this well. Sulfate concentrations in groundwater samples from this well exceed the upper tolerance limit, but, with the exception of one sample, the concentrations are less than the maximum background concentration.

Based on the limited amount of data available, it appears that groundwater in the vicinity of IHSS 118 2 may have been impacted by releases from the IHSS. Although they have been detected only sporadically, the presence of a number of VOCs in groundwater downgradient from this IHSS points to the need for further research into the types and quantities of materials that may have been released from this IHSS. Research into other possible sources of contamination in the vicinity and information regarding groundwater conditions immediately upgradient of the IHSS are also needed.

2 4.1 3 IHSS 123.1 - Valve Vault 7 Southwest of Building 707

IHSS 123 1 consists of the area where Valve Vault 7 is located south of Sage Avenue (an area of approximately 40 by 40 feet), and also consists of the drainage ditch south of Sage Avenue and west of Ninth Street (Figure 2-5). Since the spill entered a pipeline at the intersection of Sage Avenue and Ninth Street, the IHSS does not extend beyond this point.

The release consisted of process wastewater from the 800 and 400 areas, which historically has been known to contain uranium, solvents, oils, beryllium, nitric acid, hydrochloric acid, and fluoride. The transfer of liquid waste from the holding tanks at Building 881 was discontinued after personnel verified that wastewater was flowing out of Valve Vault 7. Temporary dikes were constructed to contain the overflow. A dam was constructed in the ditch east of the guard shack at Portal #1, and another dam was placed just west of Guard Shack 762. Drainage from the area was diverted to Pond B-1 Attempts were made to remove oil by using chemical absorbent bats. Environmental samples were taken from the vault and other areas of concern. Water was pumped out of the vault and the containment dikes and transferred to Waste Processing by tanker truck. Snow-melt water was retained in the ditch for several days and later transferred to Process Waste Storage (DOE, 1992b).

Based on information found in documents reviewed for the HRR, the HRR states that this site has been mislocated on IAG maps by locating it in the same area as the OPWL valve vault several hundred feet to the north (Appendix B) The HRR suggests that based on this information, the proposed boundaries defining this IHSS in the IAG be extended to include the storm runoff collection system ditch near Eighth Street and Sage Avenue and continue to the extent of Pond B-1 (Appendix B)

Other than sampling that was performed at the time of the release, no documentation was found of monitoring activities that have been performed to assess contamination associated with this IHSS The nearest upgradient sampling points are three piezometers completed in alluvium P213689, P214089, and P215789 (Figure 2-27) Borehole samples were collected from P213689 and P214089 during drilling in 1989 (the data for these borehole samples are included in Appendix F) No borehole sampling was conducted during the drilling of well P215789 Groundwater samples have not been collected from these piezometers The nearest downgradient well is alluvial monitoring well P218089, located approximately 400 feet northeast of the IHSS (Figure 2-27) Surficial material and bedrock samples were collected during the drilling of well P218089 (Table 2 11) Groundwater samples for analyses of VOCs were collected once during 1990 and once during 1991 Groundwater samples for analysis of radionuclides were collected twice during 1990 and also during 1991 (Table 2 12) Inorganic constituents were also analyzed in several of these samples

Acetone was detected in concentrations less than the detection limit in several borehole samples from well P218089 Contamination of laboratory blanks was not indicated for these samples Methylene chloride was also detected in a sample of bedrock, but laboratory blank contamination was indicated for this sample Metals detected in concentrations greater than background in surficial materials were barium, calcium, chromium, copper, lead, magnesium, vanadium, and zinc The concentrations of these metals did not exceed the maximum background concentration for alluvium Barium, calcium, and magnesium were detected in concentrations greater than background in bedrock samples with only barium being detected in concentrations exceeding the maximum background concentration for bedrock No inorganic constituents were detected in concentrations exceeding background in any sample Borehole samples were not analyzed for radionuclides

The only VOC detected in groundwater from well P218089 was methylene chloride in a sample taken May 31, 1990 No laboratory blank contamination with methylene chloride was indicated for this sample Methylene chloride was also detected in another sample analyzed for VOCs, but laboratory blank contamination was indicated for this sample Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations have exceeded background concentrations on at least one occasion Radionuclides detected at levels exceeding background levels in groundwater from this well were U-233,234, U-235, and U-238 in samples taken during 1990 Analysis of uranium isotopes was not performed on samples collected during 1991 Groundwater samples taken from this well have not been analyzed for metals

Based on the information that is currently available for borehole and groundwater samples from wells in the vicinity of IHSS 123 1, it is not possible to make any conclusions regarding the nature and extent of contamination potentially associated with the IHSS The lack of data regarding groundwater chemistry upgradient of the IHSS and the insufficient quantity of data available for downgradient locations hinders any meaningful interpretation of the data that is currently available It is possible that the above-background concentrations of uranium isotopes detected in groundwater samples from well P218089 during 1990 may be attributable to releases from this IHSS, but analysis of groundwater upgradient of the IHSS and additional analyses of samples from well P218089 would be required to substantiate such a conclusion

2 4 1 4 IHSS 135 - Cooling Tower Blowdown - Northeast of Building 374

During routine cooling tower operations, evaporation gradually concentrates dissolved solids in the cooling water To prevent salt buildup, a portion of the water is removed and replaced with fresh water This is done continuously in some RFP towers and as needed in others The removed blowdown water is treated either in the RFP's sanitary sewer system or in the waste treatment system, whichever is more convenient to the particular tower The water typically contains a corrosion-inhibiting additive Since the late 1970s, RFP has used phosphate for this purpose, prior to this time, a chromate additive was used. It is possible that prior to 1980, effluent from the cooling tower may have contained tritium, although it is not certain what the tritium source would be Standard chlorine bleach or a similar biocide is also added to the water to prevent algae growth (DOE, 1992b)

Persons interviewed for the CEARP Phase I report indicated that areas north of the Building 374 cooling tower were affected by blowdown water which may have contained chromates and algicides The possibility exists that surficial materials in the vicinity of the tower may have been impacted by releases from the cooling tower. However, Building 374 personnel stated that blowdown water is routed through an underground pipe into the RFP's sanitary sewer system for treatment. They recalled no leaks or other incidents involving blowdown water from Building 374 Any leakage or blowdown water from a source other than the underground pipe would be contained within the cooling tower building and would not affect soils around the tower (EG&G, 1990c)

According to the HRR (DOE, 1992b) there is documented use of a Building 373 cooling tower pond (Figure 2-6) The first documented use was on June 12, 1981. The cooling tower was cleaned, and the slurry portion was pumped into a small retention pond. During the night, some of the water leaked through the dirt dike and gate valve and drained into Walnut Creek (DOE, 1992b) Analyses of the cooling tower water and of Pond A-3 were conducted for phosphate, a compound added to cooling tower water as a rust inhibitor The results indicated no detectable quantities of phosphate in either source In December 1981, a new valve was installed at the pond in response to the leak (Appendix B)

A June 1, 1980, photo indicates a pond-like structure north of Building 374 Utility drawings support this as the location of the cooling tower retention pond, indicating a "holding pond" where Tank 808A and Tank 808B are now located The drawings indicate a sluice gate at the northeast corner of the pond with a connecting culvert extending in a northeasterly direction It is possible that the leak mentioned above was able to flow through this culvert to North Walnut Creek (DOE, 1992b)

No documentation was found of sampling activities that have been performed to attempt to determine if contamination exists in the vicinity of this IHSS. There are no monitoring wells located upgradient of the IHSS Several piezometers, P114589, P114789, P114889, and P119389 are located upgradient of the IHSS, but no groundwater monitoring data is available from these locations (see Figure 2-27 for well P114789) Well 1986, an alluvial monitoring well, is located approximately 500 feet northeast of the IHSS, and well 2186, a bedrock monitoring well, is located approximately 250 feet northwest of the IHSS (Figure 2-27) Both of these wells are downgradient of the IHSS Groundwater samples from both of these wells were collected once during 1986 and quarterly since March 1987 (Tables 2 13 and 2.14).

Trans-1,2-DCE, carbon tetrachloride, and methylene chloride have been detected in groundwater samples collected from well 2186 Acetone has also been detected in unquantifiable concentrations less than the method detection limit. Laboratory blank contamination with acetone and methylene chloride was also indicated for several samples from this well Metals detected in concentrations exceeding their respective upper tolerance limits include aluminum, calcium, iron, nickel, and zinc The concentrations of calcium and zinc detected, however, were all less than maximum background concentrations Dissolved chromium concentrations in all samples have been less than background Gross alpha, gross beta, plutonium-239/240, radium-226, strontium-89,90, and uranium-235 have been detected in concentrations exceeding background in groundwater samples from this well The concentrations of gross beta and uranium-235 have, however, been less than maximum background concentrations. Tritium has not been detected in groundwater from this well since monitoring began

Several VOCs, acetone, 1,1-DCE, trans-1,2-DCE, methylene chloride, PCE, 1,1,1-TCA, and TCE, have been detected in groundwater samples collected from well 1986 The detection of these compounds has been sporadic, with many only being detected once (Table 2 13) Calcium, iron, magnesium, manganese, and sodium concentrations in this well generally exceed their respective upper tolerance limits The concentrations of calcium, magnesium, and sodium are typically less than maximum background concentrations Barium and nickel have also been detected in concentrations greater than background on one occasion each Chromium has not been detected in concentrations exceeding background in this well Gross beta, plutonium-239/240, strontium-89,90, and uranium-233,234 concentrations in groundwater from this well have also exceeded background concentrations Gross beta and tritium were detected once each in concentrations exceeding background Tritium has generally not been detected in samples from this well Inorganic constituents detected in concentrations exceeding background include bicarbonate, chloride, and sulfate

Due to the insufficient quantity and quality of data currently available, it is not possible to attribute the contamination detected in wells 1986 and 2186 to possible releases from IHSS 135 With the exception of one sample from well 1986 that contained an above-background concentration of tritium, none of the constituents believed to have been released from this IHSS (chromium, phosphate, and tritium) have been detected in groundwater from wells 1986 and 2186 Analysis of phosphate in these wells has not been performed The lack of information regarding upgradient groundwater quality and the presence of other potential sources of contamination in the vicinity of these wells limits the usefulness of the existing data in determining the nature and extent of contamination associated with this IHSS.

2 4 1 5 IHSS 137 - Cooling Tower Blowdown - Buildings 712 and 713 (IAG Name Building 774)

Buildings 712 and 713 are both cooling tower facilities associated with Building 776 (Figure 2-7) Cooling tower water is made up of filtered, untreated raw water from the on-site raw water reservoir Water is removed from the cooling tower system from blowdown and drift. Drift water is water that is released to the atmosphere and sprayed to the ground surrounding the tower Water is periodically blown down to maintain a specified range of total dissolved solids A calculation done in the 1980 Environmental Impact Statement estimated that approximately 4,000 pounds of solids per year may be carried with the drift water and deposited on the surrounding soil This value is a total from all of the cooling towers on site Due to the age and use of these cooling towers, it is estimated that the ground surrounding and between the cooling towers has been impacted by the cooling tower water from drift, blowdown, and leaks These cooling towers do not receive recondensed evaporator water from Building 774 (DOE, 1980).

Chemicals were added to the cooling tower water for the prevention of biological growth, corrosion, scaling, and other effects that can foul heat-transfer surfaces and degrade performance. Prior to approximately 1976, chromates were added as a rust inhibitor (Appendix B). After that time, the use of chromates was reduced plantwide due to pressure from EPA regarding the release of chromates to the environment Sodium silicate has been used in cooling tower water as a corrosion inhibitor (DOE, 1980)

Interviewees for CEARP mentioned a release of cooling water south of Building 774 that flowed northward into North Walnut Creek. This water contained 50 mg/l total chromium. It is speculated that they were recalling a release from the Building 779 cooling tower in December 1976 (DOE, 1992b)

Prior to the early 1970s, it was routine for the cooling towers of Building 712 and 713 to blow down effluent onto the soil outside the building The blowdown water evaporated, infiltrated into the soil, or flowed into the storm water culverts and pipes and was directed to North Walnut Creek Since approximately 1974, the blowdown has entered the sanitary sewer lines and is treated at the sewage treatment plant (Appendix B)

In September 1990, a leaking cooling tower behind Building 777 was checked by RCRA personnel The cooling tower was reportedly releasing about 20 to 40 gallons per minute to the environment. It was unclear how long the leak had occurred prior to the RCRA response to the incident The releases were caused by leaks from corroded sides of the cooling tower (Appendix B)

It is believed that the cooling tower blowdown pipes leave the towers on their south sides (DOE, 1992b) These pipes are considered the most probable source of any blowdown water contamination around the cooling towers It is possible that surficial materials in the vicinity of the towers have been impacted by releases of cooling water

In 1979, a project was implemented to upgrade cooling towers sitewide The project included the collection of samples for determination of subsequent waste disposal as a result of demolition of some of the cooling towers Buildings 712 and 713 were included in the study Materials sampled included wood siding and soil samples The results of the sampling indicated that none of the materials qualified as toxic or hazardous material based on EPA guidance and extraction tests Therefore, material removed for the upgrades was disposed of in the present on-site landfill (IHSS 114) (Appendix B)

No documentation of sampling activities associated with releases from IHSS 137 was found There are no wells located upgradient of this IHSS The nearest downgradient wells are P209289 and P209389 The data available for these wells were presented in Subsection 2 4 1.1 for IHSS 118 1 Based on the current understanding of the material released from this IHSS, these data do not indicate any contamination that would be attributable to this IHSS Chromium was not detected in borehole or groundwater samples taken from these wells Several VOCs and radionuclides have been detected in borehole and groundwater samples from these locations It appears that the VOCs detected may be attributable to releases from other IHSSs such as IHSS 118 1, however, additional data are needed to determine the source(s) of these compounds These wells are also located downgradient of several other OU8 IHSSs which may have contributed to the contamination detected In particular, these wells are downgradient of IHSS 144(S) which may account for the above-background concentrations of radionuclides detected (see Subsection 2 4 1 9)

2 4 1 6 IHSS 138 - Cooling Tower Blowdown - Building 779

IHSS 138 is defined by two areas, one is a 50- by 50-foot area east of Building 779 and north of Building 727 and the other is about a 10- by 20-foot area east of building 785 (Figure 2-8) On December 8, 1976, a leak occurred in an underground line connected to the original cooling towers (Appendix B). This encompasses the 50- by 50-foot area. The leak discharged approximately 400 gallons of cooling tower effluent which were released into a storm sewer east of Building 779 and northwest of Building 727 At the time, it was stated that the spilled effluent drained toward Trench No 6 Trench No 6 was a part of the original surface water and shallow groundwater collection system north of the solar ponds (Appendix B)

Utilities personnel at RFP recalled that the 1976 spill occurred when an underground cooling tower water line broke east of Building 779 and adjacent to the northwest of Building 727 The cooling tower water was sampled following the incident and found to contain 50 mg/l total chromium and approximately 3,000 dpm/l alpha activity The ruptured line was excavated and repaired The cooling tower water line which ruptured in the incident was removed when the original cooling towers were replaced (DOE, 1992b) A FIDLER survey was conducted along the water course of the spill No readings above background were observed Additionally, soil samples were taken in the area and submitted for analysis (Appendix B) The results of the soil samples are not known Samples were also reportedly collected daily from Trench No 6, however, the sample analyses are not known (Appendix B)

On December 8, 1990, an estimated 1,000 gallons of cooling tower water overflowed from the Building 785 Cooling Tower Number 2 onto the ground The event occurred when the sump filled and water backwashed into the cooling tower and spilled out of the fan on the east side of the structure The spray from the backwash extended no more than five to six feet east of the building according to utilities personnel in Building 779 (Appendix B) The released water was sampled and was known to contain "Nalco 2826," an inorganic, phosphate rust inhibitor An Occurrence Report prepared after the incident indicated that a sample was taken for analysis, however, it was not stated if it was a soil or water sample The results of the sample analysis are not known There is no documentation to describe clean-up efforts for this spill (DOE, 1992b) It is possible that surficial materials in the vicinity of the tower have been impacted by such releases

Other than sampling that occurred at the time of the releases from this IHSS, no documentation was found regarding sampling activities that may have been conducted to define the nature and extent of contamination attributable to those releases The nearest downgradient sampling points are bedrock groundwater monitoring wells 2586, P207589, and P209089, and alluvial monitoring well 2686 (Figure 2-27) Groundwater samples have been collected from well 2586 on a quarterly basis since March 1987 (Table 2 15) The only data available for well 2686 are the analyses of inorganic constituents in groundwater Chloride, nitrate/nitrite, bicarbonate, and sulfate have been detected in concentrations exceeding background in this well Borehole samples were collected from wells P207589 and P209089 during drilling (Tables 2 16 and 2 17), and groundwater samples have been collected from these wells on a quarterly basis since 1990 Table 2.18 provides a summary of the analytical data available for groundwater samples from well P209089 As discussed below, the data available for groundwater from well P207589 are limited Wells 2386 and 2486 are located upgradient from IHSS 138 The data available for these wells are discussed in Section 2 4 1 2 for IHSS 118 2

Several VOCs have been detected in groundwater samples from well 2586 The compounds detected include acetone, benzene, carbon tetrachloride, chlorobenzene, trans-1,2-DCE, cis-1,3-dichloropropene, ethylbenzene, methylene chloride, styrene, toluene, and total xylenes Aluminum, cadmium, calcium, chromium, copper, iron, magnesium, nickel, and strontium have all been detected in concentrations exceeding background Sodium concentrations in groundwater from this well have also exceeded the upper tolerance limit, but are less than the maximum background concentration Radionuclides detected in concentrations greater than background include gross alpha, gross beta, radium-226, strontium-89,90, and uranium-238. The concentrations of uranium-238 detected, however, are less than the maximum background concentration Bicarbonate and sulfate concentrations in groundwater from this well have also exceeded background

Acetone, 2-butanone MEK, methylene chloride, and 4-methyl-2-pentanone were detected in borehole samples from well P207589. With the exception of the detection of methylene chloride and MEK in a few samples, blank contamination was indicated for all of these compounds Metals detected in concentrations exceeding background in samples of surficial materials were barium, calcium, lead, magnesium, mercury, and strontium. In addition to exceeding their respective upper tolerance limits, the concentrations of mercury in one sample and strontium in several samples also exceeded maximum background concentrations Arsenic, barium, calcium, chromium, copper, iron, lead, magnesium, nickel, vanadium, and zinc were detected in concentrations greater than background in bedrock samples The concentrations of arsenic and vanadium exceeded maximum background concentrations Nitrate/nitrite concentrations in samples of both surficial materials and bedrock exceeded background Borehole samples from this well were not analyzed for radionuclides

Groundwater samples from well P207589 have been analyzed only for VOCs and metals No VOCs or metals have been detected in concentrations exceeding background in these samples

The only VOCs detected in borehole samples from well P209089 were acetone and methylene chloride Metals detected in concentrations exceeding their respective upper tolerance limits in samples of surficial materials were aluminum, barium, cadmium, calcium, lithium, magnesium, manganese, mercury, and potassium The concentrations of cadmium, lithium, mercury, and potassium detected also exceeded maximum background concentrations Copper, lead, magnesium, vanadium, and zinc exceeded upper tolerance limits in bedrock samples, but all were less than maximum background concentrations. Radionuclides detected in concentrations above background in samples of surficial materials include americium-241, plutonium-239, radium-226, and tritium Plutonium-239, tritium, uranium-233,234, uranium-235, and uranium 238 were detected in concentrations exceeding background in bedrock samples The concentration of the uranium isotopes detected, however, did not exceed maximum background concentrations The highest concentrations of americium-241 and plutonium-239 were detected in a sample of surficial materials taken at a depth of 0 to 3 2 feet. No inorganic constituents were detected in concentrations greater than background in samples of surficial materials Nitrate/nitrite was detected in relatively high concentrations in two samples of bedrock. As indicated in Table 2.17, the concentration detected in the sample taken from depths of 11.5 to 17.5 feet is questionable because the concentration in a duplicate of that sample was two orders of magnitude less

Acetone, chloroform, ethylbenzene, methylene chloride, toluene, and total xylenes have been detected in groundwater samples from well P209089 As shown in Table 2 18, laboratory blank contamination was indicated for several of the results for acetone and methylene chloride

Analyses of metals and radionuclides in groundwater from this well have been limited The one sample analyzed for metals contained a concentration of calcium that exceeded the upper tolerance limit, but the concentration was less than the maximum background concentration Chromium was not detected in this sample Gross alpha, uranium-238, bicarbonate, and sulfate have also been detected in concentrations exceeding background

As discussed in Section 2 4 1.2 for IHSS 118 2, no radionuclides have been detected in concentrations exceeding background in groundwater from well 2386 Gross alpha and uranium-238 concentrations in groundwater from well P209089 have exceeded background The quantity of data available for this well is limited In addition, several radionuclides were detected in concentrations exceeding background in borehole samples from well P209089 These data indicate that releases from IHSS 118.2 may have impacted groundwater and soils However, there are other IHSSs, 150 6 and 150 8, that are also located upgradient of well P209089 which may have contributed to the contamination detected. In addition, other potential sources of contamination may exist in this area that are not included in OU8 Based on the data currently available, it is not possible to conclude how much of the contamination, if any, that has been detected in groundwater and soils downgradient of IHSS 138 is attributable to releases from this IHSS

2 4 1 7 IHSSs 139 1(N) and 139 1(S) - Hydroxide Tank Area - Buildings 771 & 774

IHSS 139 1 consists of three separate sites, two sites which are identified as IHSS 139 1(N), and one site which is identified as IHSS 139.1(S) The two sites identified as IHSS 139.1(N) are located north of Building 774 One of these sites consists of a sodium hydroxide tank and is adjacent to the north side of Building 774 (Figure 2-9), the other of these sites is located about 80 feet north of the first site and consists of two large steam condensate tanks (Figure 2-9 and 2-10) IHSS 139 1(S) is located south of Building 771 and consists of a potassium hydroxide tank (Figure 2-11)

Of the two steam condensate tanks, the westernmost tank receives overflow and contained liquid from the bermed area around the NaOH tank The easternmost tank receives overflow from the westernmost tank. These two tanks, T-107 and T-108, have riveted construction Currently, there is standing water around the tanks The bottoms of the tanks appear to be corroded, and there is rust on the tops and sides of the tanks (Appendix B)

The two caustic tanks, a 5,400-gallon KOH tank south of Building 771 and a 6,500-gallon NaOH tank north of Building 774, have been subject to spills and leaks in the past (Appendix B)

During the week ending May 5, 1978, a spill occurred during the routine filling of a caustic tank near Building 771 Neither the specific tank nor the quantity spilled was documented. The spilled caustic was contained by a dike below the tank and was not released to the environment. During March 1985, a pinhole-sized leak was found in the piping from the NaOH tank at Building 774 This leak occurred inside the building, "and probably did not contribute to the caustic material found on the ground in the pit surrounding the tank" Apparently, the leak had seeped along the underground pipe to the outside of the building The leak was later repaired The "caustic material found in the pit" was attributed to a poor sampling technique which allowed the valve to drip on the ground It was estimated that during the 30-year history of the tank, 80 to 100 gallons of caustics had spilled as a result of this method The pit was to be cleaned out and lined in response to the problem No documentation was found detailing the cleaning or lining of the pit (Appendix B)

In May 1985, a small leak was found at the fitting of a thermocouple in the NaOH tank north of Building 774. The caustics had solidified at the fitting, and therefore had not run into the pit. The fitting was repaired (Appendix B)

On June 22, 1987, there was an overflow of NaOH during delivery operations to the "6,000-gallon" caustic supply tank north of Building 774 because of a faulty level indicator (It is believed that this was actually the 6,500-gallon NaOH tank) Approximately 100 gallons of caustic material flowed into the bermed containment area of the tank and then drained to the caustic "catch" tank, T-108 Due to cracks in and deterioration of the concrete berm, caustic seeped onto the road Tank T-108 was also found to be deteriorating, and showed signs of seepage In response to the incident, the one to two gallons that had seeped onto the road was diluted with water and rinsed off the road. Work orders to repair the cracks in the berm were initiated, and the work was completed on June 24 A job order was submitted to replace the deteriorating catch tank, T-108 The liquid in T-108 was sampled and was to be subsequently pumped to the sanitary sewer system or Building 774 The level indicator on the caustic tank was repaired (Appendix B)

On November 13, 1989, approximately five gallons of twelve molar KOH was spilled when a vendor was refilling the holding tank near Building 771 Apparently the tank was overfilled and the extra liquid spilled into an earthen berm surrounding the tank The KOH was absorbed with approximately 100 pounds of "oil dry," a chemical absorbent, and the contaminated soil and "oil dry" were placed in an 83-gallon salvage drum on hazardous waste Unit 1 (PAC 500-903) This was shipped off site to either Nevada or Idaho based on its activity level Soil samples were taken, and pH analyses were performed It was determined that all KOH-contaminated material had been removed. The area was backfilled with new gravel It is possible that the overflowing liquid infiltrated into the soil beneath Building 771 (Appendix B)

There are limited data available that would assist in the definition of the nature and extent of potential contamination associated with releases from IHSSs 139 1(N) and 139.1(S) The only well located near or downgradient from the site of the NaOH releases (IHSS 139 1(N)) is well P219089, an alluvial well (Figure 2-27) This well is located adjacent to the NaOH tank near Building 774 Analytical data for well P219089 are limited to analysis of radionuclides and inorganic constituents in one groundwater sample collected in December 1989 Well P219189, a piezometer completed in alluvium, is located west-northwest of the tanks in this IHSS and is not downgradient of the IHSS Borehole samples were collected from this well during drilling, but groundwater samples have not been collected from this well Due to the lack of groundwater data for this well and the absence of wells downgradient of the IHSS, the analytical data for this well is of limited use in defining the nature and extent of contamination associated with this IHSS

All of the tanks in this IHSS are above the high water level elevation based on water level elevations recorded for wells P219089 and P219189 since their installation in 1989 At both wells the alluvial material is thin, from 8 to 11 feet. Relatively impermeable materials at shallow depths (Arapahoe Formation claystone at about 8.0 feet below the surface in well P219089 and clay at about 4 0 below the surface in P219189) most likely prevent a downward migration of potential contaminants and limit saturated thickness. As indicated by the high water level map for the uppermost hydrostratigraphic unit depicted in Figure 1-27, groundwater flows in a strong northerly gradient toward North Walnut Creek, essentially ridding the groundwater system of potential contaminants as seeps into the surface water system along the drainage valley walls Standing water, described as currently existing around tanks T-107 and T-108, is most likely due to ponding of runoff which is held by low permeability surficial materials and does not reflect the level of the water table

The pH of the one sample of groundwater collected from well P219089 exceeded the background Ph Although a relatively high Ph in groundwater may be indicative of the release of NaOH, the lack of additional groundwater monitoring data from this well hinders a determination of whether this result represents actual groundwater conditions or may be spurious. Chloride and plutonium-239/240 were also detected in concentrations exceeding background The concentration of plutonium-239/240 was, however, less than the maximum background concentration Uranium-233,234 was also detected in this sample Interpretation of this uranium concentration is difficult in that the background concentration of uranium-233,234 is based on the analysis of only one sample

The nearest wells to IHSS 139 1(S) are the same as those discussed in Subsections 2 4.1.1 and 2 4 1 2 for IHSSs 118 1 and 118.2 (Figure 2-27). As discussed in those subsections, however, these wells are not located downgradient of these IHSSs Due to the nature of the liquids believed to have been released from IHSS 139 1(S), it is unlikely that the liquids could have migrated to the locations of the wells discussed in Subsection 2 4 1.1 and 2 4 1.2 Any detectable residual impact to environmental media would likely be confined to the immediate vicinity of the releases

2 4 1 8 IHSS 139 2 - Hydrofluoric Acid Tank Area (Building 714)

IHSS 139 2 consists of two horizontal, 1,300-pound HF cylinders, each with a 1,200-pound capacity, that are located in Building 714 (Figure 2-11) The hydrofluoric acid is delivered to the RFP in portable cylinders, which are replaced when empty No open transfer of the acid takes place The acid is piped to and used in Building 771 (Appendix B)

During May 1971, there was a small vapor release from the hydrofluoric connection outside Building 771. No documentation was found which detailed a response to the release (Appendix B)

During the week ending August 13, 1976, a hydrofluoric acid leak above Building 771 was repaired Apparently the hoses had collected small amounts of the acid that appeared when the line was pressurized (Appendix B).

It is improbable that the acid releases have had a residual impact on the air There was no documentation of events that may have impacted the soil, surface water, or the groundwater. Additionally, it is improbable that there was impact on surface water or groundwater (Appendix B)

In addition to the above description of IHSS 139 2, there is a portable, refillable nitric acid dumpster located just north and west (approximately 25 feet) of the hydrofluoric acid storage area discussed in the IHSS 139 2 description More precisely, the dumpster is located at the southeast corner of Building 771 It is possible that leaks and spills in the vicinity of the dumpster have impacted the environment. As stated in Section 2 3 8, this area is not part of an OU8 IHSS or PAC, but investigations are planned for a 10-foot area around the dumpster

According to Supervisor Investigation Report #87-7-771 1 - Acid Spill, there was a release of approximately 35 gallons of 12 normal nitric acid at the dumpster on July 1, 1987 (Appendix B) The cause was a leak in the supply hose Neutralization was attempted by the use of potassium hydroxide flake and sodium bicarbonate The following day, the soil was loosened and more sodium bicarbonate was added An asphalt layer was discovered approximately 6 inches below the ground surface The affected soil was removed to hazardous waste unit number 1 (PAC 500-903) or to IHSS 203 New road mix was to be placed on the asphalt pad (Appendix B)

The dumpster involved supplied nitric acid to the Building 771 chemical makeup area The acid was delivered to the 218 tank farm near Building 444 by an outside supplier One of two available dumpsters was picked up at Building 771, taken to the bulk supply, and filled by Building 774 Chemical Operators The dumpster was then returned to Building 771 This process occurred on a daily basis when Building 771 was operational as a plutonium recovery facility (Appendix B)

The nearest wells to this IHSS that may assist in evaluating the nature and extent of contamination associated with the IHSS are the same as those discussed in Subsection 4 2 1.1 for IHSS 118 1 (Figure 2-27) These wells, however, are not located downgradient of IHSS 139.2 There are no wells located downgradient of this IHSS. Any residual impact from these releases, if detectable, would likely be confined to the immediate vicinity of the IHSS and would be unlikely to have impacted groundwater

2 4 1 9 IHSS 144 - Sewer Line Breaks - Near Building 730, Tanks 776 A-D (IAG Name. Sewer Line Break)

IHSS 144 consists of two separate sites, IHSS 144(N) (Figure 2-12) and IHSS 144(S) (Figure 2-13) IHSS 144(N) consists of four underground waste holding tanks located north of Building 776 and east of Building 701, in a small structure identified as Building 730 These tanks are designated as Tanks 776 A through D They were built in approximately 1956, and were taken out of service in the 1980s They are now used as plenum deluge tanks and, therefore, would normally be dry (Appendix B)

The tanks are concrete and are non-inspectable Tanks 776 A and B are laundry waste holding tanks, and Tanks 776 C and D are process waste holding tanks If tanks C and D overflowed, the excess liquid could drain into Tanks A and B, and vice versa. Therefore, it appears that volatile organic and semi-volatile organic compounds, metals, and radionuclides are potential contaminants

On approximately June 1, 1972, a revision of a Building 776 radiography vault floor drain was completed Apparently, previous transfers of laundry waste water from Tanks 776 A and B resulted in backflow into the vault. The revision to the floor drain, involving relocation of the drain pipe connection, would allow the waste to be transferred at higher pressures (Appendix B)

On June 7 or 8, 1972, the increased pumping rate during a transfer of laundry wastewater from Tanks 776 A and B to Building 995 caused suspension of high-level sediment in the tanks and pressurization of the sanitary waste line. The pressurization of the line caused a toilet and sink in Building 701 to overflow and a patch to rupture in the line east of the waste holding tanks Due to the overflow of the toilet and sink, the toilet, sink, and floor of Building 701, as well as the ground east of the building, were contaminated The patch that ruptured was apparently located between Buildings 777 and 779, this location has been designated as IHSS 144(S) Since the exact location of the sewer line break between Buildings 777 and 779 is unknown, the boundaries of IHSS 144(S) include all of the alleyway At the time of the incident, maintenance may have consisted of cleaning out a clean-out plug near Building 701, further increasing the potential impacts on the environment (Appendix B)

Activities of samples taken from the toilet bowl in Building 701 were as high as 136,000 pCi/l on June 7 and 8 A sludge sample taken from a clean-out plug in the Building 701 sanitary sewer line contained only minimal radioactivity Analyses of the sediments from the bottoms of Tanks 776 A, B, and D indicated liquid phase activities of 68,000 pCi/l, 9,100 pCi/l, and 302,000 pCi/l, respectively (Appendix B)

Interviewees for CEARP Phase I recalled a sewer line break between Buildings 779 and 777, which was discovered when contamination was found in a restroom It is believed that this is the same incident as the 1972 patch rupture discussed above

The rupture in the line patch east of the tanks resulted in soil contamination Approximately 50 drums of soil were removed A conflicting document states that 38 drums of soil were removed The contaminated soil around Building 701 was also apparently removed. It is probable that residual soil contamination is present. As of June 8, 1972, 19 drums of soil had been removed No soil count was detected at that time (Appendix B) Disposal of these drums was at either the present landfill (IHSS 114) or, if contaminated (definition of "contaminated" not provided), at Idaho

The radiometric survey performed with a FIDLER in the late 1970s and early 1980s indicated no extremely contaminated (500,000 to 1,000,000 pCi/g) areas at or near this IHSS (Appendix B)

Following the 1972 pressurization incident, the Building 995 outfall and other downstream points were sampled daily There was increased radioactivity in the Building 995 outfall The highest sample concentration of total alpha-emitting radionuclides in the outfall was 417 pCi/l on June 11, 1972 (Appendix B)

The nearest wells to IHSS 144(N) are the same wells discussed in Subsection 2 4 1.1 for IHSS 118 1 As discussed in that subsection, these wells are not located downgradient of these IHSSs There are no wells located downgradient of IHSS 144(N)

There are no wells located immediately upgradient of IHSS 144(S) The nearest upgradient well is well P214689, located approximately 1,300 feet to the southwest. As discussed in Subsection 2 4 1 1, the data available from this well are of limited use in establishing upgradient groundwater conditions Several wells and boreholes are located downgradient of the IHSS Alluvial monitoring wells 2286, 5687, and P209289, and bedrock monitoring wells P209189, P209389, and P210189 are located downgradient of this IHSS (Figure 2-27) Summaries of the available analytical data for groundwater samples from wells 2286, 5687, and P210189 are provided in Tables 2 19 to 2 21 The available data for wells P209189, P209289, and P209389 are discussed in Subsection 2 4 1 1 for IHSS 118 1 Borehole samples were also collected from well P210189 during drilling (Table 2.22) In addition, borehole SP16-87 is located downgradient of IHSS 144(S) A summary of the analytical data available for borehole samples from borehole SP16-87 is provided in Table 2.23 (Subsequent to its drilling, borehole SP16-87 was completed as well 5687)

As shown on Table 2 19, several VOCs have been detected in groundwater samples from well 2286 Many of these compounds are the same as those detected in groundwater samples from well P209189 (see Table 2 9) With the exception of TCE, which has been detected routinely (Figure 2-29), most of these VOCs have been detected sporadically Metals detected in concentrations exceeding background in groundwater from well 2286 include aluminum, antimony, barium, calcium, chromium, iron, lead, lithium, magnesium, manganese, nickel, and sodium The concentrations of calcium, magnesium, manganese, and sodium have all been less than maximum background concentrations Radionuclides detected in concentrations greater than background are americium-241, cesium-137, plutonium-239/240, strontium-89,90, tritium, and uranium-233,234 Gross alpha and beta concentrations have also exceeded their respective upper tolerance limits but have not exceeded maximum background concentrations Chloride, nitrate/nitrite, sulfate, and bicarbonate concentrations have also exceeded background Groundwater samples collected from this well were analyzed for pesticides and polychlorinated biphenyls (PCBs) in September 1986, but none were detected

Samples of groundwater collected from well 5687 have also contained a variety of VOCs, many of which are the same as those detected in wells 2286 and P209189 (Table 2.20) PCE, TCE, 1,1,1-TCA, and their degradation products have been detected in most samples from well 5687 (Figure 2-30) Metals detected in concentrations exceeding background in this well include calcium, copper, lead, mercury, nickel, sodium, and zinc. Calcium and sodium concentrations, however, have not exceeded maximum background concentrations Chloride, nitrate/nitrite, sulfate, and bicarbonate concentrations have also exceeded background in groundwater samples from this well Groundwater samples from this well have not been analyzed for radionuclides

Samples of surficial materials and bedrock from borehole SP16-87 were analyzed for metals, radionuclides, and inorganic constituents No analyses of VOCs were performed on these samples As indicated in Table 2.23, several metals were detected in concentrations greater than background in samples of both surficial materials and bedrock. Only copper, potassium, and zinc were detected in concentrations that exceeded both upper tolerance limits and maximum background concentrations in surficial materials Cadmium, arsenic, calcium, and manganese concentrations in bedrock exceeded both upper tolerance limits and maximum background concentrations Americium-241, gross alpha, and plutonium-239/240 were detected in concentrations exceeding background in a sample of surficial materials taken from 0 to 2 feet deep Uranium-233,234 and uranium-238 also exceeded upper tolerance limits but did not exceed maximum background concentrations No radionuclides were detected in concentrations exceeding background in bedrock samples Nitrate/nitrite concentrations exceeded background in samples of both alluvium and bedrock

Methylene chloride and acetone were detected in several borehole samples from well P210189 but, with the exception of methylene chloride in one sample, blank contamination was indicated for those samples (Table 2.22) Several metals were detected in concentrations greater than background in samples of surficial materials, but only barium, cadmium, and potassium were detected in concentrations that exceeded both upper tolerance limits and maximum background concentrations Chromium and vanadium were detected in concentrations exceeding upper tolerance limits and maximum background concentrations in one sample of bedrock. Several other metals were also detected in concentrations greater than upper tolerance limits but less than maximum background concentrations in bedrock samples Gross alpha, gross beta, americium-241, plutonium-239/240, radium-226, strontium-90, tritium, uranium-233,234, uranium-235, and uranium-238 were all detected in concentrations exceeding background in surficial materials Plutonium-239 and tritium were also detected in concentrations exceeding background in bedrock samples Uranium-233,234 and uranium-238 concentrations in bedrock samples exceeded upper tolerance limits but did not exceed maximum background concentrations Nitrate/nitrite was detected in concentrations exceeding background in samples of both surficial materials and bedrock The pH of a sample of surficial materials taken from 0 to 3 feet deep also exceeded background

As shown on Table 2.21, a variety of VOCs have been detected in groundwater samples from well P210189, many of which are the same as those detected in the other wells located downgradient of this IHSS PCE, TCE, and degradation products of these two compounds have been detected in several samples collected from this well (Figure 2-31) Barium, calcium, iron, and mercury concentrations in groundwater from this well have exceeded their respective upper tolerance limits, but the concentrations of calcium detected have been less than the maximum background concentration Plutonium-239/240, radium-226, tritium, and strontium-89,90 have also been detected in concentrations exceeding background Nitrate/nitrite and bicarbonate concentrations in groundwater from this well have also exceeded background concentrations

The available data for wells downgradient of IHSS 144(S) indicate contamination that may be attributable, at least in part, to releases from this IHSS Many of the constituents detected in samples from these wells are not known to have been released from this IHSS and may have resulted from releases from other OU8 IHSSs or other potential sources of contamination Insufficient information is currently available regarding the composition of materials released from this IHSS

2 4 1 10 IHSS 150 1 - Radioactive Site North of Building 771

Wastes from Building 771 and materials to be reprocessed in Building 771 were frequently handled and stored in the area north of the building. Building 770, north of 771, was built in 1965 and has been used as a residue storage area in the past. Activities in and around Building 770 have contributed contamination to this site (DOE, 1992b) IHSS 150.1 is an area approximately 360 by 60 feet and is adjacent to the north side of Building 771 (Figure 2-14)

The following is a chronological breakdown of incidents that have occurred in this area and utilization changes

On September 11, 1957, the RFP's first major fire occurred in Building 771. A plenum was breached releasing an unknown amount of radioactivity around the building, particularly to the north The impact the airborne radioactivity may have had on the access road was not quantified, however, fire clean-up activities followed the incident (Appendix B)

From approximately 1962 until approximately 1968, a 5,000-gallon stainless-steel tank was located approximately 30 feet north of Building 771 The tank was on 6-foot legs and was approximately 8 feet in diameter Two overhead pipes from Room 114 in Building 771 connected to the tank, one of which was a vacuum vent to control transfer in and out of the other The tank was used in the Filtrate Recovery Ion Exchange system, which concentrated plutonium and americium for recovery. Americium concentrated on an ion exchange column and was transferred at a predetermined concentration to the tank The resulting liquid contained in the tank was a nitrate solution high in americium with some plutonium (Appendix B)

In approximately 1968, a pinhole leak developed in the tank and dripped onto the slab foundation The tank was temporarily sealed to mitigate the leak until the tank could be emptied through the processing of the contained solution Once emptied, the tank was taken out of service and remained in place until it was moved to the size-reduction facility in Building 776 sometime shortly after Once size-reduced, the tank was disposed of as radioactive waste in Idaho When the tank was removed to the size-reduction facility, the concrete slab was decontaminated until the point where smear samples did not detect further removable radioactivity Paint was applied to the concrete to secure the fixed radioactivity The slab was moved to a ditch directly north of the area and buried (IHSS 163 2) The area was paved sometime prior to June 1969 (Appendix B)

On June 11, 1968, during the removal of drums from the 903 Storage area, a drum leaked on the roadways as it was being transported to Building 774 The forklift carrying the leaking drum traveled across the access road north of Building 771 The area near Building 774 was contaminated at the time The road in front of Building 771 was apparently not considered to be impacted by the incident Further details of this incident are provided in the IHSS 172 description (Appendix B)

The paved area between Buildings 771 and 770 was used for the storage of residue in drums prior to processing in Building 771 A June 1969 photograph shows over 100 drums stored in rows on the pavement. A fence parallel to Building 771 also encloses the west entrance to Building 770 and defines a storage area Drums were also stored in the courtyard south of Building 770 between the access road and the building This location has since been altered, because in the 1960s there was a concrete embankment wall along the south and east sides of the courtyard There is currently no embankment wall. Construction changes in this area are not clear More information may be found regarding the physical alteration of the area. Drums of waste from the 1969 fire in Building 776 were stored in the area for counting prior to shipment (Appendix B)

Another specific incident of contamination occurred on November 16, 1970, when residue leaked out of a drum of filters as it was being transported from a storage area (triangle area east of the solar ponds) to Building 771 for processing The ground area near the dock at Building 771, as well as the truck and cargo container the drum had come in contact with, were all contaminated The leak was detected while in transit, and the area was decontaminated It was noted in March 1971 that there was a significant increase in the number of "hot waste" drums were stored outside in the area north of Building 771 These drums contained residues for the Building 771 incinerator and the number of drums in storage was becoming problematic for the Health Physics Operations Group (Appendix B)

On June 11, 1971, a leaking drum on the pavement caused the contamination of approximately 115 square feet of asphalt. Soil and approximately 200 square feet of asphalt were removed for off-site disposal in Idaho A recommendation was made to lease cargo carriers to protect the drums A waste drum was found to be leaking shortly after that on July 2, 1971, and was determined to contain nitric acid from non-line generated waste A rainstorm spread the leaked contamination, affecting between 2,300 and 2,500 square feet of asphalt and gravel with levels of contamination ranging from 500 to 1,000,000 cpm plutonium The incident prompted a request for additional cargo carriers and the use of Building 776 for storage. It was determined that these incidents in June and July 1971 resulted in contamination of the area ranging from 100,000 to 300,000 dpm/100 cm^2 on the asphalt (Appendix B)

In August 1972, a punctured scrap box stored inside Building 770 contaminated 3,600 square feet inside the building and 500 square feet outside Levels of radioactivity ranged up to 200,000 dpm/cm^2 (DOE, 1992) Removal of asphalt and soil for disposal off-site in Idaho began immediately following the incident.

Finally, on September 15, 1972, a 55-gallon drum containing spent ion exchange resin residue leaked inside Building 770 onto the concrete floor Contamination was tracked between Buildings 771 and 770 and covered 600 square feet, including 50 drums and a forklift. Levels of contamination ranged from 5,000 to 100,000 cpm plutonium The area was noted to be decontaminated, but details of these activities were not found (Appendix B)

The specific locations of these incidents were not recorded, however, the paved area north of Building 771 and west of Building 770 was used for storage in a structured manner since before 1969 and probably as early as 1964 The storage area was bounded on the north by a fence that was parallel to Building 771 and extended north to enclose the west entrance of Building 770 During the time of storage, the paved area still functioned as the access road for Buildings 771 and 774 (Appendix B)

The material stored consisted primarily of residues that had a high plutonium content and were destined for plutonium recovery operations in Building 771 Materials were stored in drums on pallets or in cargo containers No documentation was found that provided any hazardous waste characteristics that may have been associated with the plutonium residue Decontamination activities conducted after specific incidents would have been focused on radioactive contamination It is likely that residual contamination from hazardous constituents may have remained (Appendix B)

Due to environmental concerns related to the clean-up activities at the 903 storage area and the triangle storage area, efforts were made sitewide in the early 1970s to move all radioactively-contaminated materials to indoor storage The Building 771 area was used for storage until approximately 1974 when Building 776 was used for such storage Building 770 was then used for the storage of equipment and also a facility for equipment assembly prior to installation in other buildings (Appendix B)

The results of the Radiometric Survey, performed at RFP during the late 1970s and early 1980s, indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) north of Building 771 (Appendix B)

Based on the boundaries of IHSS 150 1 discussed in Section 2 3 10, there are no wells or boreholes located downgradient of this IHSS The nearest well to the IHSS is well P219189, a piezometer completed in alluvium, located near the northeast corner of the IHSS (Figure 2-27) Borehole samples of both surficial materials and bedrock were collected from this well during drilling in 1989 (Table 2 24) 1,1-DCA was detected in concentrations less than the method detection limit in several samples Methylene chloride was also detected in several samples, but blank contamination was indicated for those samples.

Metals detected in concentrations greater than background in surficial materials from well P219189 were arsenic, barium, copper, iron, lead, magnesium, manganese, and zinc Only the concentrations of zinc exceeded maximum background concentrations Aluminum, arsenic, barium, chromium, iron, lead, magnesium, nickel, vanadium, and zinc concentrations exceeded background in bedrock samples The concentrations of lead and zinc detected in these samples were also greater than maximum background concentrations. As shown in Table 2 24, several radionuclides were detected in concentrations exceeding background The concentrations of americium-241, radium-226, radium-228, tritium, uranium-233,234, and uranium-238 in samples of surficial materials and of radium-226, radium-228, and tritium in bedrock samples exceeded both upper tolerance limits and maximum background concentrations None of the samples collected were analyzed for plutonium

The available analytical data for well P219189 indicate that RFP operations have impacted surficial materials and bedrock in the vicinity of IHSS 150.1 However, these data are not sufficient to enable a determination of impacts that are attributable to this IHSS The lack of data regarding groundwater quality in the vicinity of the IHSS, particularly in the downgradient direction, hinders any determination of the nature and extent of contamination potentially associated with this IHSS As discussed in Subsection 2 4 1 12 for IHSS 150 3, the contamination detected in this well may also be attributable to releases from other IHSSs or other sources of contamination

2 4 1.11 IHSS 150.2 - Radioactive Site West of Buildings 771 and 776

On September 11, 1957, a fire was discovered in Room 108 of Building 771 Fires in the box exhaust booster filters and main filter plenum were discovered soon after An explosion in the main exhaust duct probably contributed to the release of plutonium from the stack. The September 1957 fire in Building 771 released radioactive contamination primarily north and southwest of the building (DOE, 1992b)

During fire-fighting and decontamination activities at Building 771, access to the main filter plenum was gained through a hatchway on the west side of the building This activity was the main cause of the spread of contamination on the west side of Building 771 at the time of the fire (Appendix B) (Figure 2-15).

No documentation was found which details contamination of the surrounding environment. One eyewitness report states, "I then went back in the front area of Building 71 [771] with a Pee Wee and did some spot monitoring I found the general level of contamination to be 100 to 500 counts per minute, except around the air-lock to the exclusion area, where the floor had been tracked up" (Appendix B). (Note A Pee Wee was the alpha probe used in the 1950s.) The front door of Building 771 is located on the north side of the building, however, the levels may be an indication of the contamination levels in the general area. It is conjectured that the west side of Building 771 would have become more contaminated than the north side of the building, because it is believed that firefighting access was mostly through the west access door No details of cleanup activities at Building 771 were found (Appendix B)

In 1969, the west dock area of Building 776 was contaminated by tracking of contamination by firefighting personnel up to greater than 100,000 (units not known) (Appendix B) This was most likely an area just south of Door 6, in the northern half of the west side of the building, where surveys showed contamination of between 100 and 300 micrograms per square meter (Appendix B) Documentation also indicates that the steps, dock, and ramp areas on the west side of Building 776 were contaminated to 6,000 cpm (Appendix B) The contaminated area extended out from the building approximately 30 feet. Following the fire, rain transported the contamination into nearby soil Oil and gravel were placed on the soil to stabilize the contamination (Appendix B)

The following information is from records research conducted in conjunction with development of this plan (Appendix B). The soil, oil, and gravel were removed on July 19, 1969 Asphalt and dirt removed from the west side of the building contained 7 dpm/g, and was to be buried in the "Building 903 area" Contaminated asphalt, soil, oil, and gravel from the 1969 fire was actually buried in a location east of Building 881, at IHSS 130. Approximately 320 tons of soil and asphalt were removed from the west side of the building and buried in trenches It is not clear, however, whether these trenches are on- or off-site Additional interviews with individual(s) who made this claim or additional research of RFP records may provide details regarding disposal of these materials At least a portion of the sidewalk on the west side of Building 776 was also removed A new asphalt road had been constructed on top of the affected area by the end of July 1969 Airborne contamination from the May 1969 fire was carried predominantly to the west-southwest, the average wind direction at the time.

In May 1971, contaminated steps and dock and ramp areas on the west side of Building 776 were covered with an epoxy paint Areas of contamination outside Building 776 were covered with asphalt. In 1973, a survey was conducted on the asphalt road west of Building 776 to determine contamination levels prior to widening of the road The maximum soil activity found was 70 dpm/g plutonium (Appendix B) In January 1972, the soil at the southwest corner of Building 776 was considered to be contaminated (Appendix B) The cause of the contamination was not stated In June 1972, the "west dock" became contaminated when a radioactively-contaminated roller on a box was brought into the building The area was decontaminated at the time of the incident (Appendix B) No documentation providing further details of cleanup was found It was not stated what building the "west dock" was connected to, but it is possible that is was the west dock of Building 776

In June 1980, contaminated asphalt was removed from the west side of building 776 and boxed as contaminated waste (DOE, 1992b)

The results of the Radiometric Survey, performed at the RFP during the late 1970s and early 1980s with a FIDLER, indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) around the west sides of Buildings 771 or 776 (Appendix B)

There are no wells or boreholes located in the immediate vicinity of this IHSS. The nearest downgradient well is well 1986 located approximately 250 feet west of the northwest corner of the IHSS (Figure 2-27) There are no wells located upgradient of the IHSS The available analytical data for well 1986 were presented in Subsection 2 4 1 4 for IHSS 135 Several VOCs have been detected in groundwater samples collected from this well (Table 2 13) In addition, several metals, radionuclides, and inorganic constituents have been detected in concentrations exceeding background In particular, gross alpha, gross beta, plutonium-239/240, strontium-89,90, tritium, and uranium-233,234 concentrations in groundwater from this well have exceeded background concentrations

The analytical data available for well 1986 suggest that groundwater in the vicinity of IHSS 150 2 may have been impacted by releases from this IHSS The presence of above-background concentrations of several radionuclides in groundwater samples from this well may be attributable to releases from this IHSS However, the lack of information on upgradient groundwater quality and the potential that other sources of contamination exist in this area, makes such a conclusion tenuous at this time

2 4 1 12 IHSS 150 3 - Radioactive Site Between Buildings 771 and 774

During excavation for construction between Buildings 771 and 774 in August and September 1971, a cement tunnel containing PWLs, which had previously been used as an exhaust ventilation duct for Building 774, was exposed (Figure 2-16) In August 1971, leaks of liquid into Building 771 at the west end of the tunnel were attributed to releases from the process waste lines coming through the wall where pipes entered the building Also in August 1971, contaminated soil was removed from beneath the tunnel (DOE, 1992b) which was almost fully exposed on the north side at the time and taken to Idaho (DOE, 1992b). It is unknown if the soil removal was a response to the leaks into Building 771 (Appendix B).

In September 1971, continued construction resulted in more exposure of the tunnel Three cracks in the concrete walls were found to be contaminated This incident released plutonium (concentrations not specified) to the soil As a result of this incident, the cracks that were contaminated were sealed, and eight drums of soil, with approximately 24 dpm/g activity, were removed for off-site disposal (location not identified) in January 1972 (Appendix B) Clean-out and decontamination of the tunnel was completed by January 7, 1972 Repair of the cracks, as well as pipe replacement, was to be done at a later date. It was believed at the time that some contamination would remain in the concrete (Appendix B) Samples of wastewater from the pipeline indicated activity of 1,000 pCi/l (Appendix B) (isotope(s) or type of radiation detected not specified) Soil samples from the area were found to be only slightly contaminated There is no documentation regarding further response to this incident.

Personnel recall an incident in this area in the late 1970s or early 1980s A flange in a line separated, releasing an unspecified amount of aqueous process waste that reached the surface Personnel recalled that the area was cleaned up (DOE, 1992a)

Other than the sampling activities described above, no documentation was found of sampling performed to determine the nature and extent of contamination potentially associated with this IHSS Information on groundwater quality upgradient and downgradient of IHSS 150.3 is lacking Well P219189, a piezometer completed in alluvium, is located downgradient of IHSS 150 3 (Figure 2-27) The nearest wells to the south of this IHSS are P209289, an alluvial monitoring well, and P209389, a bedrock monitoring well Based on the water table maps presented in Figures 1-27 and 1-28, these wells may be upgradient of a portion of IHSS 150 3 However, as discussed in Subsection 2 4 1 1, the data available for these wells is limited Groundwater samples from these wells have not been analyzed for metals or radionuclides

Borehole samples were collected from well P219189 during drilling in 1989 The available analytical data for these samples were discussed in Subsection 2 4 1 10 for IHSS 150 1. As discussed in Subsection 2 4 1 10, several metals and radionuclides were detected in concentrations exceeding background in samples of both surficial materials and bedrock Americium-241, radium-226, radium-228, tritium, uranium-233,234, and uranium-238 concentrations in surficial materials and radium-226, radium-228, and tritium concentrations in bedrock exceeded background concentrations These samples were not analyzed for plutonium

It is difficult to draw any conclusions regarding the nature and extent of contamination associated with IHSS 150.3 based on the limited data currently available. Groundwater quality data in the vicinity of the IHSS is lacking It is possible that the contamination, particularly radionuclide contamination, detected in borehole samples from well P219189 may be attributable to this IHSS, but the existing data are not sufficient to substantiate such a finding

2 4 1 13 IHSS 150 4 - Radioactive Site East of Building 750

As discussed in Subsection 2.3 13, this area is believed to be contaminated by leaking manholes Building 750 is located south of the east side of Buildings 776/777 and 778, and directly east of Building 707 (Figure 2-17)

CEARP interviewees recalled that decontamination equipment, such as trucks, were staged in the 750 Courtyard, and that manholes had "leaked" in the same area According to former RFP personnel, the area referred to as the 750 Courtyard was the area between Buildings 750 and 707, west of Building 750 (Appendix B). No documentation was found which confirmed the staging of decontamination equipment near Building 750 Present and former RFP employees did not recall the use of the area for such activities No documentation regarding "leaking" manholes was found, however, the leak described in the following discussion may be the incident to which the interviewees were referring.

During routine foundation drain and sump sampling in 1980 and 1981, elevated levels of total dissolved solids, conductivity, gross alpha and gross beta were found in a sump located south of Building 778 just outside Door 3, in an area that would be considered to be in the 750 Courtyard These high levels were discovered during the week ending November 20, 1981 Investigation into the high levels resulted in the finding of a leaking process waste line located above the sump The leak was repaired Specific isotopic analyses indicated 900 pCi/l uranium and no plutonium (Appendix B) Whether the analyses were performed on soil or water was not specified No documentation regarding soil removal or other cleanup activities was found

This area may have also been affected by airborne contamination during the 1969 fire However, it is doubtful that decontamination vehicles were staged in the 750 Courtyard, because, to the knowledge of RFP personnel involved in cleanup after the fire, this area was not used for vehicle staging, however, if such activities did occur, it is unlikely that the environment was impacted, or that any residual contamination remains, because detailed documentation exists for the fire cleanup, and if contamination had been found, it is likely that it would have been recorded Therefore, it is suggested that this IHSS include only the area around the process waste line leak (Appendix B)

There are no wells located upgradient of this IHSS Bedrock groundwater monitoring wells 2386 and P207389 and alluvial monitoring wells 2486 and P207489 are located downgradient of the IHSS (Figure 2-27) The available analytical data for groundwater samples collected from wells 2386 and 2486 were presented in Subsection 2 4 1.2 for IHSS 118.2. Summaries of the data available for borehole and groundwater samples from wells P207389 and P207489 are presented in Tables 2.25 to 2.28 None of the borehole and groundwater samples from these wells have been analyzed for radionuclides

As discussed in Subsection 2 4 1.2, analytical data for well 2486 are limited to the analysis of VOCs and inorganic constituents in one groundwater sample collected on June 12, 1991 No VOCs were detected and nitrate/nitrite concentrations exceeded background in this samples With the exception of the detection of several VOCs in groundwater samples from well 2386, the concentrations of most constituents in that well have generally been comparable to background concentrations

The only VOCs detected in borehole samples from well P207389 were methylene chloride and acetone Blank contamination was indicated for all of the samples that contained acetone Blank contamination was not indicated for any of the samples containing methylene chloride Aluminum, barium, calcium, lithium, magnesium, and zinc concentrations in samples of surficial materials exceeded background, but only lithium was detected in concentrations greater than the maximum background concentration Calcium and strontium were detected in concentrations greater than background in samples of bedrock. The calcium concentrations, however, did not exceed the maximum background concentration for calcium. The only inorganic constituent that exceeded background was nitrate/nitrite in the 0- to 3-foot sample

The results for borehole samples from well P207489 are very similar to those for well P207389 Methylene chloride and acetone were the only VOCs detected, and blank contamination was indicated for all samples containing acetone Aluminum, barium, beryllium, calcium, chromium, copper, iron, magnesium, potassium, vanadium, and zinc concentrations in samples of surficial materials exceeded background, but only chromium and copper were detected in concentrations exceeding maximum background concentrations No metals were detected in above-background concentrations in bedrock samples Nitrate/nitrite concentrations in the 0- to 3-foot sample from this well also exceeded background

Acetone, chloroform, and methylene chloride have been detected in groundwater samples from well P207389 Only acetone was detected in a concentration greater than the method detection limit. Blank contamination was indicated for acetone and methylene chloride in several samples Calcium and mercury have been detected in concentrations exceeding background in groundwater from this well The concentrations of calcium have all been less than the maximum background concentration for calcium Bicarbonate concentrations in this well have occasionally exceeded the upper tolerance limit, but most concentrations are less than the maximum background concentration

Groundwater samples collected from well P207489 have also contained a number of VOCs in concentrations less than the method detection limits These compounds include acetone, carbon tetrachloride, and 1,1-DCE Blank contamination with methylene chloride and acetone was also indicated for several samples Calcium and magnesium have been detected in concentrations exceeding their respective upper tolerance limits but less than maximum background concentrations Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations in groundwater from this well have exceeded background, but have generally been less than maximum background concentrations

The available analytical data are of limited use at this time in defining the nature and extent of contamination associated with IHSS 150 4 Data on upgradient groundwater quality are lacking The lack of analyses for radionuclides in borehole and groundwater samples from downgradient wells further limits the usefulness of these data. Several VOCs, generally in concentrations less than method detection limits, have been detected in groundwater samples from wells downgradient of this IHSS At the location of wells 2386 and 2486, VOCs have only been detected in the bedrock well (well 2386) but have been detected in both the alluvial well (well P207489) and the bedrock well (well P207389) at the location of wells P207389 and P207489

2 4 1 14 IHSS 150 5 - Radioactive Site West of Building 707

Recent information obtained by Doty & Associates (Appendix B) indicates IHSS 150 5 to be the same as IHSS 123.2 - Valve Vault West of Building 707 In accordance with a CDH letter to DOE dated April 21, 1992, IHSS 123.2 was transferred to OU9 As such, IHSS 150.5 (and IHSS 123 2) will not be addressed further in this Work Plan for OU8

2 4 1 15 IHSS 150 6 - Radioactive Site South of Building 779

In June 1969, radioactive contamination occurred due to an improperly opened waste drum in Building 779 and was spread by pedestrian tracking to areas east and south of the building This is the same area and release as discussed in the HRR for IHSS 150.8

The release consisted of unidentified radionuclides from radioactive waste oil The area was monitored, and the results indicated that the liquid had also been tracked on the dock and on the road from the dock to the cooling tower east of Building 779 The south entrance to the building was also contaminated (DOE, 1992b) The cooling tower east of Building 779 in 1969 was located south of the existing cooling towers It is not known whether all areas affected by this incident were included in cleanup activities (DOE, 1992b)

Borehole SP03-87 is located east of IHSS 150.6 & 150 8 (Figure 2-27) A summary of the data available for borehole samples from borehole SP03-87 is provided in Table 2.29.

Soil samples from borehole SP03-87 were analyzed for VOCs, semi-volatile organic compounds, metals, radionuclides, and inorganic constituents One sample of alluvium was also analyzed for pesticides and PCBs, but none were detected Bis (2-ethylhexyl) phthalate, di-n-butyl phthalate, N-nitrosodiphenylamine, all semi-volatile organic compounds, were detected in samples of both surficial materials and bedrock The phthalates detected are common plasticizers and often result from the use of plastic containers during sampling and laboratory activities VOCs detected include methylene chloride and chloroform in bedrock samples. Blank contamination with methylene chloride and TCE was indicated for several samples from this borehole.

No metals were detected in concentrations exceeding background in samples of surficial materials from borehole SP03-87 Aluminum, arsenic, calcium, chromium, lead, nickel, and vanadium were detected in concentrations greater than background in bedrock samples, but none of the concentrations exceeded maximum background concentrations. Uranium-233,234 and uranium-238 were detected in concentrations greater than upper tolerance limits but less than maximum background concentrations in samples of surficial materials Tritium concentrations in bedrock samples exceeded background concentrations Nitrate/nitrite concentrations exceeded background in samples of both surficial materials and bedrock Based on the current understanding of the materials released, the data for borehole samples from borehole SP03-87 do not indicate contamination attributable to IHSS 150.6 & 150 8

Wells 2386, a bedrock monitoring well, and 2486, an alluvial monitoring well, are located upgradient of IHSS 150.6 & 150 8 (Figure 2-27) The data for these wells are presented in Subsection 2 4 1.2 for IHSS 118 2 As discussed in that subsection, the available data for well 2486 are limited Carbon tetrachloride, trans-1,2-DCE, methylene chloride, and TCE have been detected in groundwater samples from well 2386 The concentrations of all other constituents analyzed in groundwater from these wells have generally been comparable to background concentrations

Sampling locations downgradient of IHSS 150 6 include bedrock monitoring wells 2586 and P207589, and alluvial monitoring well 2686. The available data for wells 2586, 2686, and P207589 are presented in Subsection 2 4 1 6 for IHSS 138 The available data for well 2686 are limited to analyses of inorganic constituents in groundwater (see Subsection 2 4 1.6)

A comparison of the groundwater data available for wells 2386 and 2586 indicates that those VOCs that have been detected in groundwater from both wells (i e., carbon tetrachloride, methylene chloride, and trans-1,2-DCE) have occurred in similar concentrations upgradient and downgradient of IHSS 150.6 Several additional VOCs have been detected in well 2586 downgradient of the IHSS. In addition, gross alpha, gross beta, radium-226, strontium-89,90, and uranium-238 have been detected in concentrations exceeding background in well 2586 but have not exceeded background in well 2386. Sulfate concentrations in groundwater from well 2586 are also higher than those detected in well 2386.

Groundwater samples from well P207589, which is located adjacent to well 2586, have been analyzed only for VOCs and metals No VOCs or metals have been detected in concentrations exceeding background in these samples Well P207589 is completed in claystone while well 2586 is completed in sandstone The claystone likely prevents the migration of contaminants to the groundwater interval being sampled in well P207589

The insufficient quality and quantity of the data available for wells located near IHSS 150.6 prevents any determination of the nature and extent of contamination associated with this IHSS In particular, data are lacking regarding upgradient and downgradient groundwater quality within the uppermost flow system Data for the two wells completed in alluvium, wells 2486 and 2686, are very limited The data available for wells 2386 and 2586 indicate that groundwater near this IHSS has been impacted by RFP operations In particular, increased concentrations of radionuclides are present in well 2586 downgradient of IHSS 150.6 as compared to upgradient well 2386 Several VOCs have also been detected in relatively low (i.e , less than method detection limits) concentrations in well 2586 but have not been detected in well 2386 The extent to which these contaminants may be attributable to IHSS 150 6 is not known

2 4 1 16 IHSS 150 7 - Radioactive Site South of Building 776

This site, as with other IHSS 150 sites, was contaminated by the May 1969 fire which occurred in buildings 776/777 which are to the north of this site (Figure 2-20) Plutonium was tracked outside those buildings and onto this site by fire-fighting and support personnel and was detectable on the ground around the building Following the fire, rain carried the contamination into the soil. The spread of contamination south of Building 776 can also be attributed to the runoff of fire water sprayed on the building to contain the fire. Sand and gravel between Building 777 and Building 778 were also contaminated before the rain Airborne contamination from this incident was carried predominately to the west-southwest, the average wind direction at the time

Areas north, west, and south of the building were contaminated. The area north of the building is included in IHSS 131, which pertains to contamination resulting from a 1964 explosion incident, as well as the 1969 fire The area west of the building is included in IHSS 150 2, which pertains to contamination resulting from the 1957 and 1969 fires The following discussion emphasizes contamination on the south side of Building 776/777 resulting from the 1969 fire (Appendix B). Alpha direct survey techniques were used to delineate contaminated areas following the fire and during cleanup activities A detailed study of contamination resulting from the fire was completed by May, 1971 (Appendix B)

Contamination was found on the ground south of Building 776/777, as well as on the ground south of Building 778, to the north wall of Building 707 (Appendix B) Contamination was detected in the soil approximately 200 feet from Building 776/777 The walkway area between Buildings 776/777 and 778 was contaminated to 200,000 cpm direct and 5,000 cpm removable (DOE, 1992b).

Initially, soil in the area was covered with road oil and gravel (DOE, 1992b) The exact location of this soil is unknown By December 1969, asphalt in the area and the covered soil had been removed from between the buildings and buried in a location east of Building 881 (Appendix B) This area is IHSS 130 The walkway between Buildings 776/777 and 778 was removed in October 1971 (DOE, 1992b) No documentation was found which further details decontamination activities of the area between the buildings, nor was any documentation found which details cleanup of the area south of Building 778 (Appendix B)

In 1972, the soil at the southwest corner of Building 776/777 was considered to be contaminated (Appendix B). The levels and source of this contamination are unknown, and it is not known if it is related to the 1969 fire

One reference indicated that Building 779 was also contaminated slightly, but whether the contamination occurred inside or outside the building was not stated

The area south of Building 778, which is included in IHSS 150 4, may also be contaminated due to other incidents See the description for IHSS 150 4 for further details of contamination in the area

The nearest downgradient sampling points to IHSS 150.7 are alluvial monitoring well P209289 and bedrock monitoring well P209389 (Figure 2-27) The nearest upgradient groundwater monitoring well is well 4486 located approximately 2,000 feet southwest of this IHSS. The data available for wells P209289 and P209389 are discussed in Subsection 2.4.1 1 for IHSS 118 1 As discussed in Subsection 2 4 1.1, groundwater quality data is limited for wells P209289 and P209389, particularly with regard to radionuclide concentrations. Due to the limited quantity of groundwater data that is available for these wells, the distance between these wells and IHSS 150 7, and the presence of several other IHSSs between these wells and IHSS 150.7, the available data cannot be used define the nature and extent of contamination associated with this IHSS.

2 4 1 17 IHSS 150 8 - Radioactive Site Northeast of Building 779

As stated previously, this IHSS resulted from contaminated oil being tracked throughout the first floor, the dock, and surrounding outdoor areas south and east of Building 779 and is the same release as described for IHSS 150 6 (Appendix B) Therefore, these two IHSSs have been combined and the discussion of the nature and extent of contamination is presented in Subsection 2 4.1 15

2 4 1 18 IHSS 151 - Fuel Oil Leak - Tank 262 North of Building 374

The first documented spill at this site was on August 12, 1981, when about 196 gallons of No 2 diesel fuel were spilled on the ground north of Building 374 (Figure 2-21) An estimated 400 cubic yards of soil were affected by the 1981 spill (DOE, 1992b) The spill was 30 by 35 feet. A second spill released 50 gallons of No 2 diesel fuel in July 1982 In October 1982, 120 liters were spilled While conducting a routine system circulation of Tank 262, another spill of 10 to 20 gallons occurred in September 1988 when a vent was left open IHSS 151 is currently defined by a boundary of approximately 60 feet by 45 feet and is located north of Building 374

Reports from the 1981 incident indicated that cleanup would be initiated when the ground dried It is documented that cleanup of the saturated soil occurred adjacent to the tank surface foundation after the 1988 spill (disposal location not identified) and that the State Oil Inspector was notified A site visit conducted for the Phase I RFI/RI indicated that only small areas of staining, 1 to 3 feet in diameter, remained around the pad, suggesting cleanup of a larger 1981 spill (DOE, 1992b)

The nearest downgradient sampling location to IHSS 151 is bedrock groundwater monitoring well 2186 (Figure 2-27). Groundwater data available for this well is presented in Subsection 2 4 1 4 for IHSS 135 Although several VOCs, metals, and radionuclides have been detected in concentrations greater than background in samples from this well, these data are not indicative of releases of No 2 diesel fuel It should be noted, however, that samples from this well have not been analyzed for many of the constituents that would be expected to result from a release of diesel fuel (e g , semivolatile organic compounds)

2 4 1 19 IHSS 163 1 - Radioactive Site North of Building 774

As stated in Subsection 2 3 19, an area north of Building 774 was used for washing equipment and vehicles that were contaminated with unspecified types of radiation Personnel would use nitric acid, soap, and water for the cleaning, and the solution would flow onto the ground (Appendix B) However, Building 774 personnel did not recall this area ever being used to wash equipment or vehicles (DOE, 1992b) A former RFP employee contacted during this OU8 study recalled that the cleanup of trucks occurred near the dock at the northeast corner of the building (Appendix B)

The HRR states that the wash water would have contained low levels of unspecified radionuclides and may also have contained various unspecified organic and inorganic compounds (DOE, 1992b) As implied in Subsection 2.3.19, it is unlikely that any contaminants were released to the environment at this IHSS. In fact, no radioactivity above the response level of a FIDLER instrument (approximately two times background) was detected at this location by a radiological survey conducted from 1977 through 1984 (DOE, 1992b)

There are no wells or boreholes located within, adjacent to, or downgradient of IHSS 163 1

2 4 1 20 IHSS 163 2 - Radioactive Site North of Buildings 771 and 774

IHSS 163 2 is an area of approximately 60 by 40 feet located north of Buildings 771 and 774 An americium-contaminated slab is buried in the area near Building T771A by the Perimeter Road (Figure 2-23) The slab is approximately 8 feet square and 10 inches thick. From approximately 1962 until approximately 1968, the slab served as a foundation for a 5,000-gallon stainless steel tank located approximately 30 feet north of Building 771

In approximately 1968, a pinhole leak developed in the tank and dripped a nitrate solution high in americium with some plutonium onto the slab (Appendix B) The tank was later removed and the concrete slab was decontaminated until the point where smear samples did not detect further removable radioactivity Paint was applied to the concrete to secure the fixed radioactivity The slab was moved to a ditch directly north of the area and buried. The area was paved sometime prior to June 1969 In the mid-1970s, Building T771A, a prefabricated structure, was constructed in the same general area None of the persons interviewed for this investigation recalled any subsequent excavation of the slab. The slab lies underground near or beneath the east end of T771A at a probable depth of less than 10 feet (Appendix B)

An environmental summary report from 1973 does not indicate the incident in the summary of environmental incidents impacting the soil at the RFP, however, the report does have a notation of the slab on a map of the area north of Building 771. The report indicates an area farther to the north of where the slab is believed to be buried and states that it was later excavated and the contaminated portion cut away for off-site disposal. This is not believed to be the case The location indicated on the map cannot be accurate because it is in an area that was paved several years before the slab became contaminated As stated above, there has been no verification that the slab was subsequently excavated (Appendix B).

The results of the Radiometric Survey, conducted at the RFP during the late 1970s and early 1980s with a FIDLER, indicate no extremely-contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) north of Building 771 (Appendix B)

An Aerial Radiological Survey of the RFP conducted during July 1989 did not indicate anomalous concentrations of americium-241 in the area north of Building 771 However, the survey was not structured to identify sources that occupied a small area (200 meters in diameter was the target size and less than 10 meters in diameter would not have been detected with confidence) (Appendix B)

The 8- by 8-foot slab is probably still buried beneath the pavement near Building T771A There was no mention of americium-contaminated soil being buried with the slab, however, because the slab had been located on soil, it is likely that some soil from beneath the slab was also deposited when the slab was pushed into the ditch Because the slab had as much contamination removed as possible and was then painted to seal the fixed contamination, therefore, it is not likely that there is a significant amount of contaminated soil surrounding the slab Other material of an unknown source was backfilled into the ditch prior to the area's being graded and paved (Appendix B)

There are no wells or boreholes located within, adjacent to, or downgradient of IHSS 163.2

2 4 1.21 IHSS 172 - Central Avenue Waste Spill

As stated in Subsection 2.3.21, in June 1968 one or two drums containing plutonium-tainted oil and oils with lathe coolant (70 percent hydraulic oil and 30 percent carbon tetrachloride) leaked while in transit. Only the northbound and westbound lanes reportedly were affected (Figure 2-24) It was speculated that the drum(s) were punctured by a forklift while being loaded at the 903 Pad and were not noticed by workers until the vehicle had reached its destination at Building 771 Affected pavement was radioactively contaminated with levels up to 140,000 dpm/100 cm^2 (DOE, 1992b)

The drum released only a small portion of its contents, suggesting that the spill involved perhaps 10 gallons or less The leak resulted from sloshing of the drum contents through an improperly sealed bung during transport. Because of this, material was not likely to have spilled any more at stopping points than at other points along the route. The spill was detected when the forklift reached Building 771, and the affected roadway was quickly cordoned off An effort was made to cleanup the spill, and the roadway was seal-coated before being reopened to RFP traffic (DOE, 1992b)

An unknown amount of "low-level material" reportedly spread to the ditch along the north side of Central Avenue as a result of this spill Aerial photographs taken in 1969 of RFP show that this ditch ran along essentially the entire affected length of Central Avenue Most of the ditch has since been paved over, lined with concrete, or filled in by subsequent construction Available references do not indicate what area(s) of the ditch received contamination Because the release was relatively small and the cleanup response was very timely, significant contamination of the ditch is not expected (DOE, 1992b).

Most of the affected roadway has since been repaved and remains heavily used. A section of Central Avenue between Eighth and Tenth Streets was removed in August 1970 and placed in an asphalt dumping area east of Building 881 (IHSS 130). The section of Sixth Street between Sage Avenue (outside the Protected Area) and the perimeter road within the Protected Area was removed during Protected Area construction between late 1980 and late 1982 The fate of the removed asphalt is not known (DOE, 1992b).

Because of the small quantities of material believed to have been released during the incidents described above, the cleanup efforts undertaken at the time of these incidents, and the disturbance of the areas affected by construction activities and paving, it is unlikely that contamination attributable to these releases would be detectable in boreholes or wells located adjacent to or downgradient from the roadways Any residual contamination from these releases is likely to be confined to the immediate vicinity of the roadway and unloading points.

2 4 1 22 IHSS 173 - Radioactive Site - 900 Area (Storage Vaults Near Building 991)

IHSS 173 is located adjacent to the southwest side of Building 991 (Figure 2-25) Incidents involving very small quantities of plutonium, uranium, and beryllium have been noted in Building 991 The south dock of Building 991 is located on the west side of the building and was used for loading and unloading assembly components into the vaults (Buildings 996 through 999).

According to former RFP employees, the dock and courtyard were often washed down with water, which could seep into cracks and the edge of the asphalt (Appendix B)

Cleaning of depleted uranium parts was conducted in the courtyard of Building 991, which is located on the west side of the building near the dock, in the late 1950s and early 1960s Acetone and solvents were used for cleaning of parts and the spent cleaning solutions were stored in drums and removed for disposal. Spills and water could have drained into storm drains These washing activities were conducted along the north wall of the asphalted courtyard (Appendix B)

The storage vaults and tunnels associated with Building 991 and Buildings 996 through 999, are used for storing finished uranium, plutonium, and beryllium parts prior to off-site shipment. The finished product was not considered radioactive because the components were plated with nickel The vaults have reportedly been subject to infiltration of groundwater (Appendix B) The structural integrity of the vaults was compromised during construction of Building 771, due to the driving of heavy equipment over the area. According to a recent newspaper article, water is entering the tunnels through fractures in the walls, ceilings, and floors Materials being stored in the area will be removed as a safety precaution (Appendix B)

According to CEARP Phase I, routine surveys of the vaults have indicated that they are free of radioactive contamination, with the exception of tunnel 996, which might be slightly infiltrated by uranium (DOE, 1992b) However, the August 1981 aerial radiological survey recorded 8,000 -16,000 cpm of gross "man-made" radioactivity and 1,000 - 2,000 cpm of americium activity centered around Building 991 (EG&G, 1990c) Final products containing plutonium and uranium were shipped from the dock, but no raw products were involved in the operations ongoing within Building 991 No documentation was found detailing constituents which may be present in the dock area, nor was documentation available detailing responses to occurrences in the dock area (DOE, 1992b)

The IAG indicates that the entire building and the area over the tunnels and vaults should be included in the IHSS primarily because of the age of the structures. However, interviews and documentation indicate that activities which may have affected the site took place only at the south dock of Building 991 Even though there was no documentation found indicating potential for contamination of this area, it is believed from interviews with retired RFP personnel involved with the activities of this area that the south dock would have a greater probability than the building or vaults of being potentially contaminated. Therefore, it was proposed in the HRR that this IHSS be reduced in size to include only the southwest corner of Building 991. The south half of the building was used for offices and the northern half for laboratories and research. No documentation exists for the entire building being considered potentially contaminated (DOE, 1992b)

Alluvial monitoring well 2187 and bedrock monitoring well 2287 are located downgradient of IHSS 173 approximately 450 feet to the east (Figure 2-27) Groundwater samples have been collected from these wells on a quarterly basis since March 1988 Summaries of the data available for these wells are provided in Tables 2 30 and 2.31. There are no wells located immediately upgradient from this IHSS

Acetone and PCE have been detected in groundwater samples collected from well 2187. Carbon disulfide and methylene chloride were also detected at concentrations less than method detection limits Blank contamination with methylene chloride was indicated for at least one sample collected from this well Analyses of metals and radionuclides have been limited. One sample analyzed for metals detected calcium, copper, magnesium, nickel, sodium, and zinc in concentrations exceeding background The concentrations of magnesium and sodium detected were less than maximum background concentrations. Uranium-233,234 and uranium-235 have been detected in concentrations exceeding background in this well. One sample was analyzed for plutonium, but none was detected. Bicarbonate, chloride, and sulfate concentrations in this well have also exceeded background concentrations

One groundwater sample collected from well 2287 contained a detectable concentration of PCE One sample also contained MEK at a concentration less than the method detection limit. Acetone and methylene chloride were detected in several samples, but blank contamination was indicated for those samples Calcium concentrations in groundwater from this well have exceeded background, but have all been less than the maximum background concentration for calcium Americium-241, cesium-137, strontium-89,90, and uranium-235 have also been detected in concentrations exceeding background Sulfate concentrations in this well have exceeded background, but are generally less than the maximum background concentration.

The groundwater chemistry data available for wells 2187 and 2287 indicate that groundwater downgradient of IHSS 173 has been impacted by RFP operations The detection of acetone and PCE in groundwater collected from well 2287 indicates that the possibility that these constituents may have been released from this IHSS cannot be ruled out at this time The above-background concentrations of several radionuclides detected in groundwater samples from both wells may also be attributable to releases from this IHSS As discussed in Subsection 2 4 1.23, these wells are also downgradient of IHSS 184 which may also have contributed to the levels of radionuclides detected.

2 4 1 23 IHSS 184 - Radioactive Site - Building 991 Steam Cleaning Area (near Building 992)

The Low-Priority Sites report states an area southwest of Building 991, near Building 992, was used for the steam cleaning of equipment and drums (Figure 2-25). The rinse water was collected in a sump for treatment in RFP's process waste system. The results of the Radiometric Survey, conducted during the late 1970's and early 1980's with a FIDLER, indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) at this site (DOE, 1992b)

As stated in subsection 2.3.23, Building 991 personnel indicated that steam cleaning was done in an area within the southwest corner of the Building 991, not beside the guard shack or elsewhere outside the building Wash water ran into an outside drain which flowed south and east beneath pavement before emptying into an unlined ditch just southeast of the building Although not included with this IHSS, the 400 linear feet downstream (east) of the IHSS will be investigated utilizing radiation surveys and possibly sediment sampling

CEARP interviewees recalled that there was a small contaminated spot on the ground that was cleaned up Approximately 3 feet were excavated during cleanup and disposed of in Idaho It was stated that this occurred on the north side of Central Avenue, southwest of Building 991 (Appendix B), however, the exact location was not stated. Many spots of contamination had been detected in the past in soil along Central Avenue in this area due to the presence of the Mound, Trench No 1, and Oil Burn Pit No 2 It is unlikely that the 3 feet of contaminated soil was associated with the steam cleaning activities

The IAG indicates that spillage from IHSS 184 is visible on August 6, 1971 aerial photographs of the RFP Originals of these photographs are relatively sharp but small-scale (approximately 1 in = 2,200 ft), and spillage emanating from the steam cleaning area was not identified under 10x stereoscope magnification Small discolored areas perhaps are evident on the ground east of Building 991, but do not appear to originate at the steam cleaning area. Building 991 personnel indicated that steam cleaning was discontinued prior to the aerial photo date (DOE, 1992b)

The nearest downgradient wells to IHSS 184 are wells 2187 and 2287. The groundwater chemistry data available for these wells is discussed in Subsection 2 4.1.22 for IHSS 173. Acetone, PCE, several metals, and several radionuclides have been detected in concentrations exceeding background in these wells. As discussed in Subsection 2.4.1.22, the levels of radionuclides detected in groundwater samples from these wells may be attributable, at least in part, to releases from this IHSS.

2 4 1 24 IHSS 188 - Acid Leak (Southeast of Building 374)

This IHSS is related to a 1983 incident recalled by CEARP interviewees in which a drum containing nitric and hydrochloric acid leaked near the east gate of Building 374. The mixed acid most likely was waste metal leaching solution from the 400 complex, and might have contained very trace amounts of heavy metals. The byproducts of the neutralization occurring by the buffering action of the soil (i.e., nitrate, chloride) would be relatively benign and highly mobile in the environment (DOE, 1992b). Very trace amounts of heavy metals could possibly remain in the surface materials

The surface was flat and unpaved at the time of the acid leak and was later paved in the mid-1980s (DOE, 1992b) Recent investigations have found no documentation regarding the incident or cleanup activities.

There is a limited amount of data available that would assist in characterizing the nature and extent of contamination potentially associated with this IHSS. Hydrogeologic conditions in the area are expected to be similar to that found in well P114789 which is over 400 feet to the south of the IHSS In this well, 26 feet of clayey sand overlie Arapahoe claystone. High water levels are within 6 feet of the ground surface It is likely that a small acid spill at the IHSS with similar hydrogeologic conditions would be rapidly diluted if it reached the water table, given the 20-plus feet of saturated material that exist during periods of high water levels.

The nearest downgradient well, 1986, is located approximately 900 feet to the northeast. Due to the distance between this well and the IHSS, the presence of other potential sources of contamination between the well and the IHSS, and the small quantity (55 gallons maximum) of liquid released during the incident, it is improbable that any impacts attributable to this release would be detected in this well. Any residual impacts from this release, if detectable, would likely be confined to surficial materials in the immediate area of the release.

2 4 2 Current Conditions within OU8 - Surface Water and Sediments

The purpose of this section is to summarize probable surface-water impacts and data requirements associated with the planned Phase I RFI/RI efforts To the extent possible, reference is made to available relevant data and information sources

Subsections 2 4.2 1 through 2 4.2.3 discuss the nature and extent of contamination associated with each cluster of IHSSs within OU8 Data on surface-water and sediment monitoring are generally not discussed on an IHSS-specific basis due to the fact that the monitoring site locations are primarily within the drainageways downstream of multiple IHSSs. Therefore, a direct correlation between identified contaminants and an individual IHSS cannot accurately be made. These discussions are based primarily on the collective documented events related to a cluster of IHSSs

Available sediment-chemistry and water-quality data from RFEDS database (DOE, 1992b) were retrieved for inclusion in this Work Plan for the following general categories of constituents

A - Radionuclides,
B - Trace metals (including major cations and silicon),
C - Pesticides, major anions, and miscellaneous chemical constituents; and
D - Volatile Organic Compounds

Relevant surface-water and sediment monitoring sites in the vicinity of OU8 are identified on Figure 2-32 This figure also indicates the types of available data for each monitoring site The data available for each monitoring site discussed in the following subsections are included in Appendix G and are summarized in tables presented in the following subsections. Table 2.32 provides a listing of all the surface-water and sediment sites in the OU8 area for which RFEDS data files were obtained. Data for a total of 19 surface-water and 7 sediment monitoring sites were included The RFEDS data files for SW119, SW120, and SW371 contained no laboratory results

A screening process was used to identify which monitoring sites and which type of contaminants at each site should be summarized in the tables This screening resulted in reducing the number of surface-water sites to 16 (Table 2.32). The number of sediment sites for which data were evaluated remained at 7 (Table 2 32) For each monitoring site, the RFEDS data included files for four different categories of contaminants (A, B, C, and D), as described above . This resulted in 64 surface water and 28 sediment data files These categories were screened to identify which type of contaminant reportedly had been released from each IHSS, as indicated previously in Table 1 2 This screening further reduced the number of data files from 64 to 42 for surface-water sites and from 28 to 21 for sediment sites

The laboratory results in the remaining data files were summarized to facilitate an assessment of relevant data. Table 2.33 provides a summary of all the VOC data above detection limits, Table 2 34, provides a statistical summary of dissolved and total trace metals for surface water sites and total trace metals for sediment sites, Table 2 35 provides a statistical summary of the indicator radionuclides dissolved and total gross alpha and dissolved and total gross beta concentrations for surface water sites, and total gross alpha and total gross beta for sediment sites. Table 2.36 provides a statistical summary of selected inorganic water-quality variables.

The available surface-water and sediment monitoring sites are located downstream of the IHSSs but not necessarily in locations which collect runoff from single IHSSs. In all but three cases, are no monitoring sites located upstream of an IHSS (Table 1.2) Given the limits of monitoring-site locations in relation to the IHSSs within OU8, individual IHSSs have been clustered in groups which contribute surface-water runoff to a common monitoring site These are referred to as cluster I through cluster III Table 2 37 provides a listing of the IHSSs located within each cluster and the category of contaminant(s) reported to have been released (Table 1.2). The resultant data were evaluated, and when applicable, selective comparisons were made with geochemical-characterization results reported in EG&G documents (EG&G 1990b, 1991c)

It should be recognized that all of the conclusions in the following subsections are preliminary in nature in that they are based upon data of limited quantity and quality in OU8 The data used in this assessment was not verified or validated in all cases Also, the surface-water and sediment monitoring sites discussed in these subsections were not installed for the purpose of defining the nature and extent of contamination associated with the individual IHSSs for OU8 Thus, the monitoring sites are not ideally located for such a purpose and are often not sampled for the constituents of interest to a particular IHSS. In addition, most of these monitoring sites are located downstream from more than one IHSS in OU8, as well as other potential sources of contamination which relate to conditions in other OUs and that are not addressed by this Work Plan

2 4.2 1 IHSS Cluster I - West OU8 Area Affecting North Walnut Creek

Cluster I consists of five IHSSs located in the northwest part of OU8 These IHSSs are identified by number as 135, 150 2, 150 7, 151, and 188 IHSS cluster I water-quality impacts are monitoring in large part at downstream surface-water site SW018 and sediment site SED010 Concerns involve all 4 water-quality categories -- radionuclides, trace metals, indicator inorganics, and organic (priority-pollutant) compounds, however, radionuclide potential impacts occur more frequently in this cluster (involving 3 of 5 IHSSs, see Table 2.37)

Surface Water

At site SW018, average dissolved gross-alpha and dissolved gross-beta concentrations (4.81 pCi/L and 8 95 Pci/L, respectively, Table 2 35) were only slightly greater than those observed at site SW122 associated with IHSS cluster III (see Section 2 4 2 3 below) and less than those observed at the other sites (SW118 and SW093) involved in this assessment (see Section 2 4 2.2 below) Hence, radionuclide-related impacts associated with upstream IHSS cluster I appear to be relatively small compared to those associated with IHSS cluster II included in this assessment.

Average trace-metals concentrations at downstream site SW018 in general are low, relative to comparable trace-metals concentrations observed for sites upstream and downstream on North Walnut Creek (Table 2.34, and see Section 2.4 2.2 below) Noted exceptions are dissolved magnesium and manganese which have concentration higher than several of the other sites being compared on Table 2.34.

Based upon tabulated selected inorganic variables for samples collected at downstream site SW018 (Table 2 36), none of the indicator constituents (nitrate/nitrite, phosphorus, sulfate, chloride, and dissolved solids were used in this assessment) appears to exhibit excessive concentrations that might indicate adverse impacts from IHSSs

Regarding detectable concentrations of organic priority pollutants (volatile/semivolatile compounds, see Table 2.33), methylene chloride was the constituent detected in 3 analyses, each occurring in 1991 It is noteworthy for this assessment that each of the detected occurrences were also detected in laboratory blanks.

Sediments

At site SED010, only one sediment sample was available for comparison with other sites This sample was collected on August 22, 1986. Other sites used for comparison are site SED118 (upstream on North Walnut Creek) and site SED009 (downstream on North Walnut Creek)

Regarding trace-metal concentrations at downstream site SED010, the concentration is generally lower than the concentrations observed at upstream and downstream sites located on North

Walnut Creek (Table 2 34) Noted exceptions are the concentrations for total magnesium, manganese and molybdenum which are higher than the other sites being compared.

Average total gross-alpha and total gross-beta concentrations at site SED010 are 10 0 Pci/L and 28 0 Pci/L, respectively (see Table 2 35) The gross-alpha value is lower than the average concentrations observed at sites SED009, SED012 and SED118 which are used for comparisons in this assessment. The concentration of total gross-beta is slightly higher at site SED010 than those concentrations observed at sites SED009, and SED012 and SED118 Due to the limited number of samples collected, (1 sample), no definite conclusions can be reached.

Of the selected inorganic variables assessed in this work plan, the average concentrations of chloride and sulfate at SED010 were much lower than the concentrations observed at sites SED009 and SED011, located downstream of clusters II an III, respectively. No values are available at site SED118 However, the average concentration of nitrate/nitrite, 20.0 mg/kg, observed at SED010 is much higher than the average concentrations observed at SED118, 3 46 mg/kg, located upstream on North Walnut Creek (see Figure 2-32) Cluster I would appear to be a source of nitrate/nitrite based on this data, but due to the small sample size at site SED010, (1 sample), no definitive conclusions can be reached

2 4 2.2 IHSS Cluster II - Northeast OU8 Area Affecting North Walnut Creek Basin

Cluster II consists of fourteen IHSSs located in the northeast part of OU8 (Table 2.37) These IHSSs are identified by number as 118.1, 137, 138, 139.1(N), 139.1(S), 139.2, 144, 150.1, 150.3, 150 6, 150 7, 150 8, 163 1, and 163.2. IHSS cluster II water-quality impacts are monitored in large part by surface-water sites SW018 and SW118 (upstream) and SW093 (downstream). See figure 2-32 for locations of these monitoring sites Concerns involve all four water-quality categories -- radionuclides, trace metals, indicator inorganics, and organic (priority-pollutant) compounds, however, radionuclide potential impacts occur more frequently, involving 9 of 14 IHSSs (see Table 2 37)

Surface Water

The average total gross-alpha and gross beta concentrations are relatively unchanged between site SW118 and SW093 indicating that no significant contributions of these indicator radionuclides have entered North Walnut Creek from cluster II However, at site SW085, located within cluster II, the mean total gross-alpha and total gross-beta concentrations observed are 89.31 Pci/L and 61 44 pCi/L, respectively These values are roughly 3 to 4 times greater than the concentrations observed at site SW093, located further downstream.

Average trace-metal concentrations at downstream site SW093 are greater than at either upstream sites SW018 or SW118 for 36 of the 66 trace metals species included in this assessment (see Table 2-34), which may indicated relative impacts of IHSSs within cluster II Of these 36 trace metal species exhibiting increased average concentrations at site SW093, 19 had an increase of two-fold or more, and 9 constituents exhibited an increase of four-fold or more Specific trace-metals species noted in this manner includes dissolved arsenic, dissolved cobalt, dissolved lead, dissolved lithium, dissolved manganese, dissolved and total molybdenum, total tin and dissolved vanadium

A concern in making a judgment is the inability of evaluating relative flow contributions from either upstream site and from intervening drainage areas as they contribute to flow monitoring at site SW093 In 17 instances, inflow average concentrations from upstream site SW118 exceeded those observed for downstream site SW093, indicating possible adverse impacts from sources outside of the OU8 area These involved primarily the total trace-metal species. The most significant increases of two-fold or more were total aluminum, total barium and total iron (Table 2.34)

It should be noted that sites SW085 and SW102, located within cluster II (see Figure 2-32), frequently had observed average concentrations far higher than those observed at SW093 These monitoring sites are located on relatively small watersheds, as compared to site SW093, and therefore, the concentrations observed at these sites are more representative of the impacts associated with the IHSSs draining through these monitoring sites Isolated average concentrations of trace-metal species at one or both of sites have exceeded the average concentration at site SW093 in 23 cases The most notable increases were average concentrations of dissolved and total beryllium at site SW102 (3 to 8 times higher than SW093) and for average concentrations for dissolved and total thallium at both sites SW085 and SW102, which were 10 times higher than the observed concentrations at site SW093

Based upon tabulated selected inorganic variables for samples collected at upstream sites SW018 and SW118 and at downstream site SW093 (Table 2.36), none of the indicator constituents (nitrate/nitrite, phosphorus, sulfate, chloride, and dissolved solids were used in this assessment) appears to exhibit excessive concentrations that might indicate adverse impacts of IHSSs Average concentrations at these sites are as follows (Table 2.36). (1) nitrate/nitrite, 1 6 mg/L at SW018, 0 45 mg/L at SW118, and 1 8 mg/L at SW093, (2) phosphorus, 0 17 mg/L at SW018, 0 05 mg/L at SW118, and 0 18 mg/L at SW093, (3) sulfate, 35 mg/L at SW018, 18 mg/L at SW118, and 35 mg/L at SW093, (4) chloride, 54 mg/L at SW018, 39 mg/L at SW118, and 40 mg/L at SW093, and (5) dissolved solids, 369 mg/L at SW081, 259 mg/L at SW118, and 317 mg/L at SW093

Regarding detectable concentrations of organic priority pollutants (volatile/semivolatile compounds, see Table 2.33), methylene chloride was the constituent detected in 3 analyses at upstream site SW018 All samples were detected in 1991. Methylene chloride (2 analyses), and acetone (1 analysis) were found at upstream site SW118 (1 sample in 1990 and 2 samples in 1991) For site SW093, a total of 6 detectable concentrations were found in 5 different samples collected in 1990 and 1991 Five (5) occurrences of methylene chloride and one (1) occurrence of tetrachloroethene were found Of 12 occurrences found at sites SW018, SW093 and SW118, all but 2 (1 methylene chloride and 1 tetrachloroethene, both at SW093) were also found in laboratory blanks

Thus, the detectable concentrations of priority-pollutants appear to occur more frequently at the downstream monitoring site SW093, which may reflect organic-contamination impacts of OU8 IHSSs predominately in the identified cluster II

Sediments

The cluster II sediment-quality impacts are monitored in large part by sediment sampling sites SED010 and SED118 (upstream) and SED009 (downstream). Also sediment sites SED120 and SED124, located within cluster II were used to compare selected data, when data was available See Figure 2-32 for locations of these monitoring sites.

Regarding detectable concentrations of organic priority pollutants (volatile/semivolatile compounds, see Table 2.33), acetone and n-nitrosodiphenylamine were found at upstream site SED010 (one sample each during 1986), and 2-butanone (1 sample), acetone (1 sample), and methylene chloride (2 samples) were found in upstream site SED118 (1 analysis in 1990, and 2 analyses in 1991) In all cases the constituents were also found in laboratory blanks.

For site SED009, located downstream of cluster II along North Walnut Creek, a total of 14 detectable concentrations were found in 5 different samples (1 in 1986, 11 in 1991, and 2 in 1992) Of the 14 detectable concentrations, 3 were acetone (2 of these were also found in laboratory blanks), 1 was benzo(a)anthracene, 1 was bis(2-ethylhexyl)phthalate, 1 was chrysene, 1 was fluoranthene, 3 were methylene chloride (all three also found in laboratory blanks), 1 was n-nitrosodiphenylamine (also found in laboratory blanks), 1 was phenanthrene, and 2 were pyrene Of the detectable concentrations not also found in laboratory blanks, fluoranthene and pyrene were also detected at site SED120 which is located within cluster II This would seem to reflect that organic-contamination impacts may be generated from the IHSSs within cluster II

Average trace-metal concentrations are generally higher at upstream sites SED010 and SED118 than at downstream site SED009 The average concentration increased between the two upstream sites and site SED009 for only 4 of the 29 constituents included in this assessment. The constituents exhibiting increased concentrations are cesium, manganese, thallium, and zinc, all of which exhibited relatively high increased concentrations in the surface-water samples also. It was noted that site SED120, located within cluster II, exhibited average concentrations higher than sites SED010, SED118, and SED009 for 8 additional constituents (calcium, chromium, copper, lead, magnesium, silver, sodium, and vanadium) All of these constituents except chromium also exhibited elevated concentrations in the surface-water samples

The average total gross-alpha concentrations (Table 2.35) increased by 50-80 percent between the upstream sites (SED010 at 10 0 pCi/L and SED118 at 12.2 pCi/L) and the downstream site (SED009 at 18 49 pCi/L) In contrast, the average total gross beta concentration for the upstream sites (28 0 pCi/L for SED010, and 27 4 pCi/L for SED118) remain relatively unchanged when compared to the downstream site, SED009 at 27.5 pCi/L A check of site SED120, located within cluster II indicates that the average total gross-beta concentration is 96 4 pCi/L which is roughly 3.5 times higher than the average concentration recorded at site SED009.

The selected inorganic variables data are somewhat limited for sediment samples Based on the data available for the three monitoring sites used for this assessment, only nitrate/nitrite, sulphate, and chloride concentrations increase between the two upstream sites (SED010 and SED118) and the downstream site SED009. It is not possible to attribute the increases in sulphate and chloride to contributions from cluster II because no data for these contaminants are available at SED118, located upstream of site SED009

2 4 2 3 IHSS Cluster III - South OU8 Affecting South Walnut Creek

A comparison of available water-quality data at surface-water site SW122 with similar data at other surface-water sites was made to assess possible OU8-related impacts at these monitoring locations in the RFP surface-water system However, it needs to be kept in mind that water-quality impacts at these locations are possible (undoubtedly probable, see Table 1.3) from IHSSs included in other OUs

Cluster III consists of five IHSSs located in the south part of OU8. These IHSSs are identified by number as 118.2, 123.1, 150 4, 150 7, and 172 IHSS cluster III (adjusted to exclude IHSSs 173 and 184) water-quality impacts are monitoring in large part at downstream surface-water site SW122 Concerns involve only 2 of the 4 water-quality categories -- radionuclides and organic (priority-pollutant) compounds.

Surface Water

Regarding detectable concentrations of organic priority pollutants (volatile/semivolatile compounds, see Table 2 33), methylene chloride (3 analyses), and acetone (1 analysis) were the constituents detected It is noteworthy for this assessment that priority-pollutant data were available for 3 samples collected during late 1990 and 1991 at this downstream site All of these detected pollutants were also detected in associated laboratory blanks.

At site SW122, average dissolved gross-alpha and dissolved gross-beta concentrations (4.66 pCi/L and 17 50 pCi/L, respectively, Table 2.35) were less than those observed at the other sites (SW018 and SW093) involved in this assessment (see above discussions). Hence, radionuclide-related impacts associated with upstream IHSS cluster III appear to be less than those associated with other OU8 IHSS clusters included in this assessment.

Sediments

Sediment data were available along North Walnut Creek downstream of Cluster III The nearest downstream sediment monitoring site is SED011 Further downstream is sediment monitoring site SED012 The data available for site SED012 were limited to only 1986 collection dates

Organic priority pollutant compounds were assessed at sites SED011 and SED012 to determine which compounds were found in detectable concentrations and in what frequency at site SED011, six detectable organic compounds were found in 7 different samples between 1986 and 1991, 2-butanone (1 occurrence), acetone (6 occurrences), carbon tetrachloride (1 occurrence), chloroform (1 occurrence), methylene chloride (4 occurrences), tetrachloroethene (2 occurrences), and trichloroethene (1 occurrence) Methylene chloride and acetone were found in laboratory blanks in 7 of the 10 analysis At site SED012, only acetone (2 occurrences, 1 laboratory blank), and toluene were found in detectable concentrations.

The average total gross-alpha and gross-beta concentrations were found to be 11 9 pCi/L and 10.0 pCi/L, respectively at site SED011, and 3 5 pCi/L and 11 3 pCi/L, respectively at site SED012, located further downstream These concentrations are relatively low when compared to the average values reported downstream of clusters I and II (see previous discussion) It does not appear from the limited data available that excessive concentrations of indicator radionuclides can be attributed to IHSSs within cluster III.

2.5 CONCEPTUAL MODELS OF RELEASES AND RECEPTOR PATHWAYS

2 5.1 Summary of IHSS Conceptual Models

A conceptual model of exposure pathways was developed here for each of three IHSS groups in OU8 using the known site physical conditions and potential contaminant sources described in

Sections 2 3 and 2 4 The conceptual models were developed for use in the evaluation of potential risks of OU8 contamination to human health and the environment. The IHSSs were organized into the three groups to simplify the conceptual models The IHSSs are categorized based on contaminant source type and release mechanisms

The three groups are as follows

Group I - Leaks, Spills, and Overflows of Tanks and Pipelines Originating Below Ground Surface

Group II - Releases Associated with Fires and Explosions

Group III - Leaks, Spills, and Overflows of Tanks, Pipelines, and/or Drums Originating Above Ground Surface

The primary purpose of a conceptual model is to aid in identifying exposure pathways through which human and biotic receptors may be exposed to contaminants. The EPA defines an exposure pathway as ".. a unique mechanism by which a population may be exposed to chemicals at or originating from the site . " (EPA, 1989a)

As shown in Figure 2-33, an exposure pathway includes a contaminant source, a release mechanism, a transport medium, an exposure route, and a receptor An exposure pathway is not complete without each of these five components The individual components of the exposure pathway are defined as follows

- Contaminant Source For purposes of the OU8 conceptual models, the contaminant source is divided into primary and secondary sources (media that potentially have been affected by these releases)

- Release Mechanism Release mechanisms are physical and/or chemical processes through which contaminants are released or interact from one or more sources. The conceptual model identifies mechanisms that released contaminants directly from the primary sources (e g , leaks, spills, overflows, etc.), and mechanisms that may release contaminants directly from the secondary contaminant sources

- Transport Media The environmental media into which contaminants are released from the source and from which contaminants are in turn released to a receptor are transport media Potential transport media for OU8 include air, surface water, vadose zone, groundwater, and biota.

- Exposure Route Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor Exposure routes for receptors at OU8 are inhalation, ingestion, and dermal contact.

- Receptor Receptors are human or environmental populations that may be affected by the contamination released from an IHSS or group of IHSSs Human receptors for OU8 include RFP workers and visitors Off-site populations are considered receptors of secondary releases carried off site by secondary release mechanisms Environmental receptors are biota (both flora and fauna) indigenous to the OU8 environs

2 5.2 OU8 Generalized Conceptual Model

A diagram of the conceptual models for potential contaminant sources, transport media, exposure routes, and potential receptors relating to the OU8 IHSSs is presented in Figure 2-33 The various aspects of the conceptual model are explained in the following sections.

2 5 2 1 Contaminant Sources

The IHSSs that constitute OU8 are located inside and around the Protected Area of the RFP. This area is physically enclosed with a security fence. Access is restricted to authorized personnel or visitors escorted by authorized personnel.

Contamination sources within the various IHSSs include above-ground and underground tanks, underground pipelines, equipment decontamination areas, and releases inside buildings which may have affected areas around the buildings Additional sources not associated with known IHSSs may include footing drains beneath the 700-series buildings. Contaminants from these sources may have been introduced into the environment through spills on the ground surface, underground leakage and infiltration, explosion and/or fire, and in some cases through incident precipitation run-on and run-off Contamination may still be entering the environment from some of the sources, in other areas, the sources may be exhausted or may have been physically mitigated through remediation at the time of the initial release.

Contaminants first enter the environment through air, surface water, and/or soil, and are transported by various mechanisms from affected media to unaffected media Contaminants remain in the air for a relatively short duration, however, surface water, sediments, and soils may become host media because they can store contaminants for longer periods of time Unaffected media such as groundwater can then become affected as a result of contact with contaminated infiltrating surface water, in-situ sediments, and/or soil Generally, once a medium is contaminated, it in turn may become a secondary contaminant source. Therefore, for conceptual purposes, contaminated surface water, soil, sediments, and groundwater are considered secondary contaminant sources in each IHSS

The chemical composition of the contaminants varies widely between the IHSSs, ranging from low-level mixed wastes to nonradioactive organic and inorganic compounds.

Air transport of contaminants is likely to have occurred during several incidents within OU8 involving fires and/or explosion Settling of contaminated airborne dust and tracking of contamination by firefighters may have affected surrounding soils, surface water, and sediments In addition, surface water transport of contaminants is likely to have occurred as a result of runoff of firefighting water and/or chemicals

In the unsaturated (vadose) zone, free liquids are expected to move generally downward to the water table, which varies in the OU8 area from a few to more than 10 feet, depending upon location and time of year. If, however, the leakage or release rate exceeds the infiltration capacity of the soil, or if the surface is covered with an impermeable material (e g , asphalt), then the liquid may pool or flow across the material surface to a more permeable material where infiltration can occur In an instance where the release is from a pressurized source (e g., pressurized pipeline), or the rate of leakage from an underground release exceeds the soil's infiltration capacity, the release may rise to the surface. This has occurred during a number of historical pipeline and valve vault leaks at the RFP Liquids infiltrating the soil may also encounter a less permeable layer (low-flow boundary) and flow laterally through the more permeable soil along the boundary At the RFP, such permeability contrasts are likely at the alluvium/bedrock contact.

Most RFP pipelines and footing drain systems are believed to be bedded either in sand or in native soil backfill Hydraulic conductivity in clean sand typically ranges from approximately 10^{-3} to 1 cm/sec. The hydraulic conductivity in the Rocky Flats Alluvium, the deposit in which the majority of RFP pipelines and footing drains are believed to be located, ranges from approximately 7×10^{5} to 1×10^{-2} cm/sec. The Valley Fill Alluvium, another common deposit at the RFP, has a hydraulic conductivity that ranges from 5×10^{-6} to $1\ 8 \times 10^{-3}$ cm/sec (EG&G, 1991g) (EG&G, 1991h) The hydraulic conductivity of unconsolidated deposits such as the Rocky Flats Alluvium is expected to increase when the deposit is disturbed (i.e., excavated and replaced as backfill material) due to increased porosity in the disturbed material

It is therefore considered likely that most pipeline and footing drain releases initially flowed preferentially through the trench materials and permeated the surrounding native soils to a much lesser extent than the trench materials Over time, the released materials may gradually have infiltrated surrounding native soil, particularly the soil beneath the trench. Thus, contaminant plumes from pipeline and footing drain releases are expected to be strongly aligned along their respective trenches, and perhaps to extend below the trenches into underlying soils Groundwater that may periodically or perennially saturate these trenches can also be expected to flow preferentially through the trench materials Any resulting spread of contamination should remain strongly oriented along the trench

Contaminant plumes resulting from slow, gradual pipeline and footing drain leaks may be less prevalent along trenches than those from releases with higher flow rates It is probable that many pipeline leaks occurred that were never detected due to low flow rate It is also probable that some major or catastrophic releases were preceded at the same location by a longer period of slow leakage as the pipeline gradually failed However, it is still considered likely that the relatively much higher hydraulic conductivity of the trench materials will control the orientation of contaminant plumes from gradual leaks, albeit to a lesser degree than those from more sudden releases

Tank releases are most likely to occur at tank openings (i e., overflows), tank/pipe connections, the base of the tank where residual waste collects, places where underground tanks may be in contact with groundwater, at cold joints along the walls of concrete tanks, and at structural beams that could be affected by differential settlement of the tank bedding or supports.

Releases from such locations would likely affect the environment immediately surrounding the tank, particularly where the release is from an underground tank bedded in backfill. Based on these conceptual tank release locations, contamination will most likely exist beneath or near external connections and openings, near joints or corners around underground tanks, and beneath the base of the tank.

Most IHSSs in OU8 overlie or are immediately adjacent to other nearby IHSSs Thus, it may not always be possible to differentiate between contamination from specific IHSSs. Therefore, the precise extent of contamination from a given IHSS may be difficult or impossible to determine

2 5 2 2 Potential Transport Mechanisms and Receptors

As mentioned above, potential transport mechanisms in OU8 include air, surface water, vadose zone, and groundwater Air pathways will be addressed by surface soil, sediment, and soil gas characterization The surface water pathway will be addressed by surface water and sediment sampling The groundwater pathway will be addressed by subsurface soil and water sampling and hydrostratigraphic unit examination through the use of soil and bedrock boreholes and groundwater wells Individual IHSS potential contaminant pathways may commingle with pathways from other IHSSs

Potential contaminant receptors include RFP workers, off-site residents, and terrestrial and aquatic biota. These receptors could be exposed to OU8 contaminants through ingestion, inhalation, or dermal contact (Figure 2-34)

Air

Potential movement of contaminants (particles) by wind is possible wherever contaminated soils exist or at IHSSs that are uncovered (e.g , no asphalt pavement or concrete). The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity Dust-borne contaminants mobilized by wind have been documented in some areas of the RFP

Some releases involving constituents such as VOCs, while impacting air quality for a time near the release, typically do not spread contamination to secondary media through the air transport mechanism However, organic vapors emanating from soils in the vadose zone can serve as an indicator of subsurface releases and potential soil contamination The movement of organic vapors through soil is controlled by the specific properties of the contaminant and the soil as well as other physical parameters and physical characteristics of the soil

Surface Water and Sediments

Surface soils and sediments may have been affected by releases that originated at the ground surface or releases that have surfaced from underground leaks Surface water runoff across these areas could then move the contamination into nearby drainages or surface impoundments A system of collection ditches and ponds control runoff at the RFP Some of these ditches and ponds are under investigation as separate IHSSs and sometimes separate OUs

It is possible that surface water may also be indirectly affected by contaminated groundwater discharging to surface water bodies such as ditches, ponds, and creeks from footing drains beneath the 700-series buildings and natural seeps

Vadose Zone and Groundwater

Groundwater recharge from incident precipitation may occur through uncovered ground surfaces within the RFP It is anticipated that mobile constituents of contamination in uncovered areas may eventually migrate into the vadose (unsaturated) zone, or eventually to the groundwater system Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP Contaminants underlying these sources can be expected to reach the water table more quickly Soils overlain by pavement and buildings, on the other hand, may be subject to little or no downward percolation of water, and contaminants in such soils may remain relatively immobile

2 5.3 GROUP-SPECIFIC CONCEPTUAL MODELS

This Section presents a general summary of the OU8 characteristics by group, followed by descriptions of group-specific contaminant sources, release mechanisms, transport media, exposure routes, and receptors Section 2.5.3 is summarized in Figure 2-33 Detailed descriptions of the backgrounds and physical settings of the IHSSs making up these groups were presented in Section 2 3 Section 2 4 presented detailed information on the nature and extent of contamination specific to each IHSS

2.5.3.1 Group I - Leaks, Spills, and Overflows of Tanks and Pipelines Originating Below Ground Surface

Most of the IHSSs in this group are associated with either the PWLs, or the Cooling Towers This grouping is primarily based on similar contaminant types (generally process wastes) and release mechanisms (leaks and overflows) The OPWL system is considered a separate Operable Unit (OU9) More specific information regarding OU9 may be found in the Final Phase I RFI/RI Work Plan for OU9 (EG&G, 1992b)

The specific IHSSs associated with Group I are: IHSS 118 1 - Solvent Spills West of Building 730, 123.1 - Valve Vault 7 West of Building 707; IHSS 135 - Cooling Tower Blowdown Northeast of Building 374, IHSS 137 - Cooling Tower Blowdown Buildings 712 and 713 (IAG Name Building 774), IHSS 138 - Cooling Tower Blowdown Building 779, IHSS 144 - Sewer Line Breaks - near Building 730, Tanks 776 A-D, IHSS 150.3 - Radioactive Site Between Buildings 771 and 774, and IHSS 150 4 - Radioactive Site East of Building 750. Figure 2-35 presents a schematic diagram of the conceptual model for Group I

2.5 3 1 1 Contaminant Sources and Release Mechanisms

Primary Sources and Release Mechanisms

IHSS 118 1 - Solvent Spills West of Building 730 (IAG Name Multiple Solvent Spills West of Building 730)

The primary source of contamination at IHSS 118 1 is considered to be a 5,000-gallon underground carbon tetrachloride storage tank that was located adjacent to the west side of Building 730 It is speculated that the tank or its associated pipes may have been releasing the carbon tetrachloride into the ground

The primary release mechanisms at this IHSS are believed to be overflow and leakage, and also direct pumping onto the ground Several incidents involving leakage have been reported In one such incident the tank failed, releasing carbon tetrachloride into the tank's sump. The sump subsequently pumped some of the liquid onto the ground surface

IHSS 123 1 - Valve Vault 7 Southwest of Building 707

The primary source of contamination at IHSS 123.1 is considered to be Valve Vault 7, which is located to the southwest of Building 707, adjacent to the north side of the PA inner fence Valve Vault 7 controls the 800 Area main PWL

The primary release mechanism at this IHSS is a leak/overflow A check valve in Valve Vault 7 malfunctioned allowing process wastewater to backflow into the sump. The vault filled with process wastewater and overflowed The process wastewater drained into an adjacent storm runoff collection system ditch near Eighth Street and Sage Avenue and flowed east toward South Walnut Creek and the B-Series drainage ponds Runoff was noticed flowing across the former 750 Parking Lot, through the Building 991 normal runoff drainage

IHSS 135 - Cooling Tower Blowdown - Northeast of Building 374

The primary source of contamination at IHSS 135 is suspected to be the Building 374 cooling tower which may have released blowdown water to the area. It is suspected that this water contained chromate and/or tritium Blowdown water is typically routed through an underground pipe into the RFP's sanitary sewer system for treatment.

The primary release mechanism at this IHSS is unknown No leaks or other incidents involving blowdown water from Building 374 has been documented The only known release involved the use of a Building 373 cooling tower pond. The cooling tower was cleaned and the slurry portion was pumped into a small retention pond. This pond is believed to have been north of Building 374 where Tanks 808A and 808B are now located. Overnight, some of the water leaked through the dirt dike and gate valve and drained into Walnut Creek.

IHSS 137 - Cooling Tower Blowdown - Buildings 712 and 713 (IAG Name: Building 774)

The primary source of contamination at IHSS 137 is considered to be one of the two cooling towers associated with Building 776. These cooling towers were originally thought to be associated with Building 774 Cooling tower blowdown pipes leave the cooling towers on their south sides These pipes are considered the most probable source of any blowdown water contamination around these cooling towers

The primary release mechanism at this IHSS was leakage. In September, 1990 it was reported that cooling tower water containing 50 mg/l total chromium was being released through a leak caused by corroded metal pipes. The leak originated from either the Building 712 or 713 cooling tower. The leak has been estimated to have involved a flow rate of between 5 and 20 gallons per minute The duration of the leak was unknown, but could have occurred several months prior to reporting

IHSS 138 - Cooling Tower Blowdown - Building 779

The primary source of contamination at IHSS 138 is considered to be an underground cooling tower water line east of Building 779 that released cooling tower water containing 50 ppm chromium and 3,000 dpm/l alpha activity An additional source at this IHSS is the Building 783, #2 cooling tower An estimated 1,000 gallons of cooling water containing an inorganic phosphate rust inhibitor was released from this tower in 1990

The primary release mechanisms at this IHSS are thought to be a leak in a cooling tower water line and an overflow in the Building 785, #2 cooling tower

IHSS 144 - Sewer Line Breaks - near Building 730, Tanks 776 A-D

The primary sources of contamination at IHSS 144 are considered to be four underground waste holding tanks located north of Building 776 and east of Building 701 in a small structure identified as Building 730. They are designated as Tanks 776 A through D Tanks 776 A and B were laundry waste holding tanks, and Tanks 776 C and D were process waste holding tanks

The primary release mechanisms associated with this IHSS are leaks and overflows. In 1972, increased pumping rate during a transfer of laundry waste water from Tanks 776 A and B to Building 995 caused suspension of high level sediment in the tanks and pressurization of the sanitary waste line The pressurization of the line caused a commode and sink in Building 701 to overflow, and a patch to rupture in the line east of the waste holding tanks. Due to the overflow of the commode and sink, the toilet, sink, and floor of Building 701, as well as the ground east of the building, were contaminated. The patch which ruptured was apparently located between Buildings 777 and 779 At the time of the incident, maintenance may have been cleaning out a clean out plug near Building 701, further increasing the potential impacts on the environment

IHSS 150 3 - Radioactive Site Between Buildings 771 and 774 (IAG Name· Radioactive Leak Between Buildings 771 and 774)

The primary source of contamination at IHSS 150.3 is believed to be process waste lines in a cement tunnel running between Buildings 771 and 774 The primary release mechanism at this IHSS is leakage of the PWL

IHSS 150 4 - Radioactive Site East of Building 750 (IAG Name· Radioactive Liquid Leaks East of Building 750)

The primary source of contamination and the primary release mechanism at IHSS 150 4 are unclear IHSS 150 4 has been described as a 20- by 20-foot area northeast of Building 750. The surface is flat and mostly paved, and is used for storage, parking and loading/unloading for Building 750 The area has been paved since construction of Building 750 in 1969. In May of 1969 a fire occurred in Building 776-777 Following the fire, the tanks and pumps that handled the decontamination fluid may have been placed into the Building 750 courtyard. Several leaks have been noted from the manholes in this area since it was paved. This area is suspected to have residual contamination from the storage of the decontamination equipment, however, no documentation is available that describes the contamination of the parking area by the decontamination tanks and pumps As discussed in Section 2 3, the "leaky" manholes may be attributable to a leaky PWL

IHSS 150 4 is presented again in Group III. It is presented in both Groups due to the inability to determine whether the primary release originated above or below ground surface.

Secondary Sources and Release Mechanisms

Soils have been contaminated as a result of past releases associated with the IHSSs in Group I. It is possible that sediments, surface water, and groundwater have also been affected Carbon tetrachloride, which is the contaminant involved in IHSS 118.1, has been detected in nearby wells This indicates that soils are very likely affected at this IHSS. In light of this, soils, surface water and transported sediments, and groundwater should be considered as potential secondary sources within this group

Secondary release mechanisms associated with soil contamination in Group I IHSSs are considered to be leaching of contaminants from the soils and sediments by percolating groundwater, volatilization and dispersion of fugitive dust, and infiltration of contaminated groundwater and incident precipitation through uncovered or unlined land surfaces, depressions, and ditches

2 5.3 1.2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group I indicate that the releases could potentially have impacted the transport media of air, surface water, vadose zone, and groundwater through pathways illustrated in Figure 2-34

Air

Air is considered a transport mechanism for Group I IHSSs due to the likelihood of soils having been contaminated by releases associated with these IHSSs, and the consideration of soils as a secondary source Potential movement of contaminants (particles and volatiles) by wind is possible, especially wherever contaminated soils are disturbed, e g., by traffic, construction, or similar activities

Surface Water

Surface water is known to have been affected by releases associated with some IHSSs in this Group, specifically IHSSs 123.1, 135, and 137. In addition, precipitation runoff across soils affected by Group I IHSSs could move the contamination into nearby drainages or surface impoundments

Surface water may also have been indirectly affected by contaminated groundwater discharging into surface water bodies such as ditches, ponds, and creeks from footing drains below the 700-series buildings and natural seeps.

Vadose Zone

The vadose zone is a potential transport medium depending on the nature of the associated contaminant(s) If the contaminant is a "sinker," (e.g., a DNAPL) meaning that in its liquid state it is more dense than water, it can migrate through the vadose zone, into the water table, and to the bottom of an aquifer in hydraulic connection. Light non-aqueous phase liquids (LNAPLs) may also migrate through the vadose zone, but being less dense than water, they would float on the water table Since the vadose zone is unsaturated, volatile contaminants may volatilize and migrate through the vadose zone more readily than under saturated conditions.

Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces within some of the IHSSs associated with Group I It is possible that mobile constituents of contamination in uncovered areas eventually could leach into the groundwater system Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP, and contaminants underlying these features can be expected to reach the water table In addition to contaminant migration to the water table, it is possible that direct releases to groundwater have occurred at IHSSs that involve underground storage tanks. The water table at the RFP has been known to fluctuate several feet. During seasonal highs in the water table fluctuation cycle, the water table could rise above the base of the tank, making direct contamination likely

Exposure Routes

Contaminants released from Group I IHSSs could potentially affect receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source or transport media

Receptors

Potential human receptors include RFP workers, visitors to the site, and off-site residents Environmental receptors include biota (both flora and fauna) indigenous to the Group I IHSS localities and their environs

2 5 3 2 Group II - Releases Associated with Fires and Explosions

IHSSs were included in this group if the releases were associated with fires or explosions in the filter system These IHSSs also have similar waste types (radionuclides) IHSSs associated with this group are IHSS 150 1 - Radioactive Site North of Building 771, IHSS 150.2 - Radioactive Site West of Buildings 771 and 776, and IHSS 150.7 - Radioactive Site South of Building 776 Figure 2-36 presents a schematic diagram of the conceptual model for Group II.

2 5.3 2 1 Contaminant Sources and Release Mechanisms

<u>Primary Sources and Release Mechanisms</u>

IHSS 150 1 - Radioactive Site North of Building 771 (IAG Name Radioactive Liquid Leaks North of Building 771)

The primary sources of contamination at IHSS 150.1 are considered a fire in Building 771 and numerous releases of contaminated fluids from drums and tanks. The area is described as a 50- by 450-foot area north of Building 771 Wastes from Building 771 and materials to be reprocessed in Building 771 where frequently handled and stored here. This area is paved, and is occupied by numerous trailers, auxiliary buildings, and storage areas The surface was repaved four to five years ago Prior to this, the asphalt was badly deteriorated with soil exposed in many areas Through the course of the heavy use this area received, several unrelated incidents have occurred which impacted the area.

The primary release mechanisms associated with this IHSS were ignition, spills, and leaks The most noteworthy incidents include the following

- In the RFP's first major fire, a plenum was breached, which released an unknown amount of radioactivity around the building, particularly to the north

- A tank used to store concentrated americium for recovery developed a pinhole leak and dripped an unknown quantity of the americium solution onto the slab foundation

- A drum leaked on the roadways during the removal of drums from the 903 Storage area. The forklift carrying the leaking drum traveled across the access road north of Building 771

- Residue leaked out of a drum of filters as it was being transported from a storage area to Building 771 for processing

- A waste drum was found to be leaking and was determined to contain nitric acid from non-line generated waste A rainstorm spread the contamination, affecting between 2,300 and 2,500 square feet of asphalt and gravel

- A punctured scrap box stored inside Building 770 contaminated 3,600 square feet inside the building and 500 square feet outside.

- A 55-gallon drum containing spent ion exchange resin residue leaked inside Building 770 onto the concrete floor. Contamination was tracked between Buildings 771 and 770 and covered 600 square feet.

Decontamination activities conducted after specific incidents would have been focused on radioactive contamination. Residual contamination from other hazardous constituents may have remained

IHSS 150 2 - Radioactive Site West of Buildings 771 and 776 (IAG Name· Radioactive Liquid Leaks West of Building 771)

The primary source of contamination at IHSS 150 2 is considered to be a fire that was discovered in Room 108 of Building 771. The fire released radioactive contamination primarily north and southwest of the building Fires in the box exhaust booster filters and main filter plenum were discovered soon after An explosion in the main exhaust duct probably contributed to release of plutonium from the stack.

The primary release mechanisms associated with this IHSS were volatilization, explosion, and foot traffic During fire fighting and decontamination activities, access to the main filter plenum was gained through a hatchway on the west side of the building This activity caused the spread of contamination on the west side of Building 771.

IHSS 150 7 - Radioactive Site South of Building 776 (IAG Name· Radioactive Liquid Leaks South of Building 776)

The primary source of contamination at IHSS 150.7 is considered to be a fire that occurred in Building 776-777, as is discussed in the description of IHSS 150.2 in sections 2.3 and 2 4.

The primary release mechanism at this IHSS was foot traffic. Plutonium was tracked outside those buildings and onto this site by fire fighting and support personnel Following the fire, rain carried the contamination into the soil. The spread of contamination south of Building 776 can also be attributed to the runoff of fire water sprayed on the building to contain the fire. Sand and gravel between Building 777 and Building 778 were also contaminated before the rain.

Secondary Sources and Release Mechanisms

Soil was affected in the vicinity of these IHSSs as a result of spills, leaks, fallout deposition, and fire-fighting activities Soil may have been exposed in the area directly around Building 770 and beneath the concrete foundation slab of the americium tank. These areas have subsequently been paved Though removal of contaminated soils was undertaken, it is likely that residual soil contamination still exists Therefore, soils within the IHSSs associated with this group should be considered a potential secondary source

Sediments may have been affected from contaminated fallout and from affected surface water Sediments should also be considered a potential secondary source

Secondary release mechanisms associated with Group II's soil contamination are considered to be leaching of contaminants from the soils and sediments by percolating groundwater; volatilization and dispersion of fugitive dust; and infiltration of contaminated groundwater.

2 5 3.2 2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group II indicate that the releases could potentially have impacted the transport media of air, surface water, vadose zone, and groundwater through pathways illustrated in Figure 2-34.

Air

Movement of contaminants by wind was highly likely due to the fact that volatilization was one of the primary release mechanisms for all three IHSSs in Group II Wind movement is also possible, especially when contaminated ground surface is disturbed If the locations of these IHSSs have been covered with pavement, the likelihood of airborne contamination decreases greatly from the secondary sources

Surface Water

Surface soils and sediments have been affected at the IHSSs in this Group The activities associated with these IHSSs included the application of water to fight fires Fire-fighting water and precipitation runoff across these areas may have moved the contamination into the nearby drainages at the time of the incidents Precipitation runoff subsequent to these incidents may have also moved contaminants from secondary sources to nearby drainages.

Surface water may also have been indirectly affected by contaminated groundwater discharging into surface water bodies such as ditches, ponds, and creeks from footing drains below the 700-series buildings and natural seeps

Vadose Zone

The vadose zone is a potential transport medium depending on the nature of the associated contaminant(s). If the contaminant is a "sinker" (e g., a DNAPL), it can migrate through the vadose zone, into the water table, and to the bottom of an aquifer in hydraulic connection. LNAPLs may also migrate through the vadose zone, but being less dense than water, they would float on the water table Since the vadose zone is unsaturated, volatile contaminants may volatilize and migrate through the vadose zone more readily than under saturated conditions

Groundwater

Groundwater recharge from incident precipitation (and in this case--from fire-fighting activities) occurs through uncovered ground surfaces All of the IHSSs associated with Group II occurred in and around uncovered ground surfaces It is anticipated that mobile constituents of contamination in these uncovered areas have leached into the groundwater system Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no vertical infiltration of water, and contaminants in such soils may remain relatively immobile.

Exposure Routes

Contaminants released from Group II IHSSs could potentially affect receptors through inhalation of airborne particles, and through ingestion of or dermal contact with contaminated source or transport media.

Receptors

Potential human receptors include RFP workers, visitors to the site, and off-site residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group II IHSS localities and their environs

2 5 3 3 Group III - Leaks, Spills, and Overflows of Tanks, Pipelines, and/or Drums Originating Above Ground Surface

This grouping is primarily based on similar release mechanisms. The IHSSs associated with this group are IHSS 118 2 - Solvent Spill South End of Building 776, IHSS 139.1(N) and (S) - Hydroxide Tank Area - Buildings 771 & 774, IHSS 139.2 - Hydrofluoric Acid Tank Area - Building 714, IHSS 150 4 - Radioactive Site East of Building 750; IHSS 150 6 - Radioactive Site

South of Building 779, IHSS 150 8 - Radioactive Site Northeast of Building 779, IHSS 151 - Fuel Oil Leak - Tank 262 North of Building 347, IHSS 163 1 - Radioactive Site North of Building 774, IHSS 163.2 - Radioactive Site North of Buildings 771 & 774, IHSS 172 - Central Avenue Waste Spill, IHSS 173 - Radioactive Site - 900 Area (Storage Vaults Near Building 991), IHSS 184 - Radioactive Site - Building 991 Steam Cleaning Area (near Building 992), and IHSS 188 - Acid Leak (Southeast of Building 374) Figure 2-37 presents a schematic diagram of the conceptual model for Group III

2 5 3 3 1 Contaminant Sources and Release Mechanisms

Primary Sources and Release Mechanisms

IHSS 118.2 - Solvent Spill South End of Building 776 (IAG Name Multiple Solvent Spills (South End of Building 776)

A 5,000-gallon above-ground carbon tetrachloride tank located within a bermed area between the north side of Building 707 and the alleyway south of Building 778 is believed to be the primary source of contamination at this site.

This tank is known to have ruptured and leaked solvent onto the ground, which contaminated the soil An unknown amount of carbon tetrachloride was released. The tank and the area of the spill were cleaned up. No documentation was found that further details response to this occurrence

IHSS 118 2 has been described as a 30- by 70-foot area south of Building 776. The primary source of contamination at this site is described as organic solvent tanks located inside Building 776 at the south end

Leaks, spills, and overflows of unknown quantities are believed to have occurred from these tanks during routine filling operations

IHSS 139 1 (N) and (S) - Hydroxide Tank Area - Buildings 771 and 774 (IAG Name Caustic Acid Spills)

The primary source of contamination at IHSS 139.1 is considered to be two caustic tanks, a 5,400-gallon KOH tank south of Building 771, and a 6,500-gallon NaOH tank north of Building 774 The KOH tank is located approximately 55 feet south and 35 feet east of the southeast corner of Building 771

The primary release mechanisms at this IHSS are leaks, spills, and overflows. In several incidents spills occurred during the routine filling of the caustic tanks near Building 771 Neither the specific tanks nor the quantities involved have been thoroughly documented. In several of the instances, the spilled caustic was contained by a dike below the tank, and was not released to the environment. Some small leaks have been noted in the piping from the NaOH tank at Building 774 Some leaks that have been documented indicate seepage along the underground pipe to the outside of the building.

IHSS 139.2 - Hydrofluoric Acid Tank Area- Building 714 (IAG Name: Caustic/Acid Spills)

The primary sources of contamination at this IHSS are considered to be two horizontal, 1,300-pound HF cylinders, each with a 1,200-pound capacity. They are located in Building 714, a small shed approximately 4 feet east and 29 feet south of the southeast corner of Building 771.

The primary release mechanism at this IHSS is leakage. A small vapor release from the HF connection outside Building 771 and an HF leak above Building 771 have been noted.

Apparently, the hoses had collected small amounts of the acid which appeared when the line was pressurized

IHSS 150 4 - Radioactive Site East of Building 750 (IAG Name Radioactive Liquid Leaks East of Building 750)

The primary source of contamination and the primary release mechanism at IHSS 150.4 are unclear IHSS 150 4 has been described as a 20- by 20-foot area northeast of Building 750 The surface is flat and mostly paved, and is used for storage, parking, and loading/unloading for Building 750. The area has been paved since construction of Building 750 in 1969. In May of 1969 a fire occurred in Building 776-777 Following the fire, the tanks and pumps that handled the decontamination fluid may have been placed into the Building 750 courtyard Several leaks have been noted from the manholes in this area since it was paved. This area is suspected to have residual contamination from the storage of the decontamination equipment, however, no documentation is available that describes the contamination of the parking area by the decontamination tanks and pumps Manhole leaks are believed to be related to a leaking above ground PWL

IHSS 150 6 - Radioactive Site South of Building 779 (IAG Name: Radioactive Liquid Leaks South of Building 779)

The primary source of contamination at IHSS 150.6 is considered to be an improperly opened waste drum in Building 779 IHSS 150.6 has been described as a 100- by 200-foot area south of Building 779. The surface is relatively flat and mostly paved.

The primary release mechanism at this IHSS is unknown (i.e., how the contamination escaped the waste drum) The contamination was spread by pedestrian tracking to areas east and south of the building (see also IHSS 150 8) An unknown number of drums of soil were subsequently removed for off-site disposal

IHSS 150 8 - Radioactive Site Northeast of Building 779 (IAG Name Radioactive Liquid Leaks Northeast of Building 779)

As in IHSS 150 6, the primary source of contamination at IHSS 150 8 is considered to be the improperly opened waste drum in Building 779 IHSS 150.8 has been described as an 80- by 120-foot area east of Building 779 The area is flat and includes both paved and unpaved surfaces

Again, the primary release mechanism at this IHSS is unknown, and the contamination was spread by pedestrian tracking The contamination was spread to the walkways east and south of the building, as well as to the dock and adjacent ground

IHSS 151 - Fuel Oil Leak - Tank 262 North of Building 374

The primary source of contamination at IHSS 151 is considered to be Tank 262, a 47,500-gallon underground storage tank The area has been described as a 30- by 35-foot area centered over Tank 262 north of Building 374 It is overlain by a 15- by 25-foot concrete pad.

The primary release mechanisms at this IHSS are several low volume (100 gallons or less) spills of No 2 diesel fuel

IHSS 163 1 - Radioactive Site North of Building 774 (IAG Name: Radioactive Sites #3 Wash Area)

The primary source of contamination at IHSS 163 1 is considered to be decontamination wash water IHSS 163 1 has been described as a 60- by 150-foot area northwest of Building 774 The eastern half of the area is mostly flat and paved and is covered in part by Trailer T771G The area was repaved four to five years ago The western half is unpaved, slopes to the north, and is crossed by an unpaved solar evaporation pond access road.

It is believed that the area north of Building 774 was used to wash radioactively contaminated equipment, and that the wash water flowed onto the ground However, Building 774 personnel did not recall this area ever being used to wash equipment.

IHSS 163.2 - Radioactive Site North of Buildings 771 and 774 (IAG Name. Radioactive Sites #3 Buried Slab)

It is unknown if contaminants are being released at this site. If so, the primary source of contamination is considered to be an americium-contaminated slab buried in the area near Building T771A (by the Perimeter Road). IHSS 163 2 has been described as a 50- by 50-foot area north of Buildings 771 and 774, outside the Protected Area just southeast of Parking Area #71

The slab which measures approximately 8-feet square and 10-inches thick, originally served as a foundation for a 5,000-gallon stainless steel tank located approximately 30 feet north of Building 771 The tank was used to store a nitrate solution high in americium with some plutonium. The slab was contaminated from a leak in the tank. When the tank was removed, the concrete slab was decontaminated until the point where smear samples did not detect further removable radioactivity Paint was applied to the concrete to secure the fixed radioactivity. The slab was moved to a ditch directly north of the area and buried The area has subsequently been paved There is evidence of subsequent excavation of the slab, however, it is not conclusive.

IHSS 172 - Central Avenue Waste Spill

The primary source of contamination at IHSS 172 is considered to be a drum that was being transported from the 903 drum storage area to Building 774 (or possibly Building 771) IHSS 172 follows the path formerly used by vehicles to transport drums of waste between the 903 Pad, where the drums were stored, and the waste treatment facility in Building 771.

The primary release mechanism at this IHSS is leakage One or two drums containing plutonium-tainted oil and oils with lathe coolant (70 percent hydraulic oil and 30 percent carbon tetrachloride) leaked along this path while in transit. It was speculated that the drum(s) were punctured by a forklift while being loaded at the 903 Pad and were not noticed by workers until the vehicle had reached its destination at Building 771. An unknown amount of "low-level material" may spread to the ditch along the north side of Central Avenue as a result of this spill.

IHSS 173 - Radioactive Site - 900 Area (Storage Vaults near Building 991)

The primary source of contamination at IHSS 173 is not specifically known Incidents involving very small quantities of plutonium, uranium, and beryllium, have been noted in Building 991. The south dock of Building 991 is located on the west side of the building and is a loading facility for the tunnels. This IHSS encompasses the dock areas southwest of Building 991.

Release mechanisms are believed to be small spills that have occurred in the area and small parts and equipment decontamination in the dock area.

IHSS 184 - Radioactive Site - Building 991 Steam Cleaning Area (near Building 992)

The primary source of contamination at IHSS 184 is considered to be steam cleaning that was done in an area within the southwest corner of the Building 991. IHSS 184 has been described as a 50- by 50-foot area near Building 992, just southwest of Building 991 It lies entirely within IHSS 173 This area possibly was used to steam clean radioactively contaminated equipment and drums The rinse water was collected in a sump for treatment in the RFP's process waste system The cleaning was done on a concrete floor that is still in place Wash water ran into an outside drain which flowed south and east beneath pavement before emptying into an unlined ditch just southeast of the building The drain system is also still in place.

IHSS 188 - Acid Leak Southeast of Building 374

The primary source of contamination at IHSS 188 is considered to be a 55-gallon drum of mixed hydrochloric and nitric acids IHSS 188 is an area of approximately 70 by 110 feet southeast of Building 374 The surface was flat and unpaved at the time of the release and was later paved in the mid-1980s.

The primary release mechanism at this IHSS is leakage of the drum. The mixed acid was probably waste metal leaching solution from the 400 complex and might have contained trace amounts of heavy metals.

Secondary Sources and Release Mechanisms

Soils are known to have been contaminated as a result of past releases associated with some of the IHSSs in Group III. Though many releases that affected soils were immediately remediated, some residual contaminated soil may still be in place. It is possible that soils, sediments, and groundwater have been affected at all of the IHSSs within this group Therefore soils, sediments, and groundwater should be considered as potential secondary sources within this group

Surface water has been affected by releases within this group introducing the potential for sediments having been affected Since this potential exists, sediments should also be considered as a potential secondary source.

Secondary release mechanisms associated with Group III's soil contamination are considered to be volatilization and dispersion of fugitive dust; percolation of infiltrating precipitation through contaminated soils and sediments; surface water transport of contaminated sediments and soils, discharge of contaminated from footing drains, and movement of contaminated groundwater.

It is improbable that the spills and leaks of caustics or acids have a residual impact on the soils Elements associated with these types of spills, such as potassium, sodium, oxygen, and hydrogen, are all naturally occurring Therefore, they would not be indicative of the releases, except by way of concentration Concentrations have likely decreased through dilution over time Carbon tetrachloride, which is the contaminant involved in IHSS 118 2, has been detected in nearby wells This indicates that soils are very likely affected at these IHSSs It is also possible that the heavy metals associated with IHSS 188 have had a residual impact to the soils, though likely minimal In light of these findings, the soils at some of the IHSSs within this group can be considered a potential secondary contaminant source

2 5 3 3 2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group III indicate that the releases could potentially have impacted the transport media of air, surface water, vadose zone, and groundwater through pathways illustrated in Figure 2-34

Air

Air is considered a potential transport medium for both carbon tetrachloride and hydrofluoric acid vapors and for surficial soils that may contain residual contamination Wind movement is also possible, especially wherever the ground surface is disturbed by traffic, construction, or similar activities Air transport of vapors emanating from VOC spills, while impacting air quality for a time near the release, typically do not spread contamination to the unaffected media.

Surface Water

Surface soils, sediments, and collection ditches have been affected by releases which originated above the ground surface in Group III IHSSs Precipitation runoff across these areas could then move the contamination into nearby drainages or surface impoundments. IHSS 173 lies within the South Walnut Creek drainage, primarily on the south-sloping north side of the drainage

Surface water may also be indirectly affected by contaminated groundwater discharging to surface water bodies such as ditches, ponds, and creeks from footing drains below the 700-series buildings and natural seeps

Vadose Zone

The vadose zone is a likely transport medium due to the nature of the contaminants associated with this group Carbon tetrachloride is a "sinker," (i.e., a DNAPL) meaning that in its liquid state, it is heavier than water and can migrate through the vadose zone, into the water table, and to the bottom of an aquifer in hydraulic connection Since the vadose zone is unsaturated, volatile contaminants such as No 2 Diesel may volatilize and migrate through the vadose zone more readily than under saturated conditions

Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces within some of the IHSSs associated with Group III Mobile constituents of contamination in uncovered areas may eventually leach into the groundwater system. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP, and contaminants underlying these features can be expected to reach the water table more quickly Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no infiltration of water. Contaminants in such soils may remain relatively immobile

Exposure Routes

Contaminants released from Group III IHSSs could potentially affect receptors through inhalation of airborne particles or vapors and through ingestion of or dermal contact with contaminated source or transport media

Receptors

Potential human receptors include RFP workers, visitors to the site, and off-site residents Environmental receptors include biota (both flora and fauna) indigenous to the Group III IHSS localities and their environs

Table 2.1

INDIVIDUAL HAZARDOUS SUBSTANCE SITES
PHASE I RFI/RI WORK PLAN
OPERABLE UNIT 8 - ROCKY FLATS PLANT, COLORADO

<u>Solvent Spills</u>

118.1 West of Building 730

118.2 South End of Building 776

123 1· Valve Vault 7 Southwest of Building 707

<u>Cooling Tower Blowdown Sites:</u>

135: Cooling Tower Blowdown-Northeast of Building 374

137: Cooling Tower Blowdown - Buildings 712 and 713 (IAG Name: Bldg.774)*

138: Cooling Tower Blowdown - Building 779

139.1 (North & South sites): Hydroxide Tank Area - Buildings 771 and 774

139.2. Hydrofluoric Acid Tank Area - Building 714

144· Sewer Line Break - near Building 730, Tanks 776 A-D (IAG Name: Sewer Line Breaks)*

<u>Radioactive Liquid Leaks (Site 150)</u>

150.1: North of Bldg. 771

150.2. West of Bldgs. 771 and 776

150 3 Between Bldgs. 771 & 774

150.4: East of Bldg 750

150.5: West of Bldg. 707**

150.6: South of Bldg. 779

150.7. South of Bldg 776

150.8: Northeast of Bldg 779

151: Fuel Oil Leak - Tank 262 North of Building 374

Table 2.1 (cont.)

INDIVIDUAL HAZARDOUS SUBSTANCE SITES
OPERABLE UNIT 8 - ROCKY FLATS PLANT, COLORADO

Radioactive Sites

163.1 Wash Area - 700 Area Site #3, North of Building 774

163.2 Buried Slab - 700 Area Site #3, North of Buildings 771 & 774

172: Central Avenue Waste Spill

173: Radioactive Site - 900 Area (Storage Vaults near Building 991)

184· Building 991 Steam Cleaning Area (near Building 992)

188: Acid Leak (Southeast of Building 374)

Source DOE, 1992a

* = Interagency Agreement (IAG), DOE, 1991

** = Pursuant to the Hazardous Release Report (DOE, 1992), IHSS 150.5 is described to be the same as IHSS 123 2 IHSS 123 2 was removed from OU8 investigations by CDH letter dated April 21, 1992, and transferred to OU9 Therefore, IHSS 150.5 is not addressed in this Work Plan.

146/266

Table 2.2

LISTING OF NON-OU8 IHSSs, PACs, and UBCs LOCATED WITHIN OPERABLE UNIT 8 BOUNDARY - ROCKY FLATS PLANT, COLORADO (refer to Figure 2-1)

Site No	Site Name	OU Number
	IHSSs	
101	Solar Ponds	OU4
112	903 Pad	OU2
117 1	North Site Chemical Storage	OU13
117 2	Middle Site Chemical Storage	OU13
117 3	South Side Chemical Storage	OU13
121	Original Process Waste Lines	OU9
123 2	Valve Vault West of Building 707	OU9
124 1	30,000 Gallon Tank (Tank #68)	OU9
124 2	14,000 Gallon Tank (Tank #66)	OU9
124 3	14,000 Gallon Tank (Tank #67)	OU9
125	Same as IHSS 124 2	OU9
126 1	Westernmost Out-of-Service Waste Tank	OU9
126 2	Easternmost Out-of-Service Waste Tank	OU9
127	Low-Level Radioactive Waste Leak	OU9
132	Radioactive Site - 700 Area Site No 4	OU9
143	Old Outfall - Building 771	OU6
146 1 to 146 6	7,500 Gallon Tanks (31,32,34W,34E,30,33)	OU9
147 1	Process Waste Line Leaks (Maas Area)	OU9
149	Effluent Pipe	OU9
150 5	Same as IHSS 123.2	OU9
152	Fuel Oil Tank	OU13
154	Pallet Burn Site	OU2
158	Radioactive Site - Building 551	OU13
159	Radioactive Site - Building 559	OU9
162	Radioactive Site - 700 Area Site #2	OU14
164 2	Radioactive Site - 800 Area Site #2, Building 886 Spills	OU14
164 3	Radioactive Site - 800 Area Site #2, Building 889 Storage Pad	OU14
165	Triangle Area	OU6
169	Waste Drum Peroxide Burial	OU13
175	S&W Building 980 Contractor Storage Facility	OU10
176	S&W Contractor Storage Yard	OU10
179	Building 865 Drum Storage Area	OU15
181	Building 334 Cargo Container Area	OU10
185	Solvent Spill	OU16
186	Valve Vault 12	OU13

Table 2.2 (cont.)

LISTING OF IHSSs, PACs, and UBCs LOCATED WITHIN OPERABLE UNIT 8

Site No	Site Name	OU Number
	IHSSs (cont.)	
187	Sulfuric Acid Spill (Acid Leaks (2))	OU12
190	Caustic Leak	OU13
192	Antifreeze Discharge	OU16
194	Steam Condensate Leak	OU16
197	Scrap Metal Sites	OU16
206	Inactive D-836 Hazardous Waste Tank	OU10
210	Unit 16, Building 980 Cargo Container	OU10
213	Unit 15, 904 Pad Pondcrete Storage	OU10
214	750 Pad Pondcrete & Saltcrete Storage, Unit 25	OU10
215	Tank T-40, Unit 55 13	OU9
	PACs	
000-500	Sanitary Sewer System	NA
000-501	Roadway Spraying	NA
300-701	Valve Vault 13	NA
300-704	Roof Fire, Building 381	NA
300-705	Potassium Hydroxide Spill North of Bldg. 374	NA
300-706	Building 374, Tank 805	NA
300-707	Sanitizer Spill	NA
300-709	Sulfuric Acid Spill, Building 371	NA
300-710	Valve Vaults 11, 12, 13	NA
500-900	Transformer 515 Leak	NA
500-901	Transformer 555 Leak	NA
700-1100	French Drain North of Building 776/777	NA
700-1101	Laundry Tank Overflow - Building 732	NA
700-1102	Leaking Transformer - Building 776	NA
700-1103	Leaking Transformers - Building 707	NA
700-1104	Leaking Transformer - Building 708	NA
700-1105	Leaking Transformers - Building 779	NA
700-1106	Process Waste Spill - Portal 1	NA
700-1107	Compressor Waste Oil Spill- Building 776	NA
700-1108	771/774 Footing Drain Pond	NA
700-1109	Uranium Incident - Building 778	NA
700-1110	Nickel Carbonyl Burial West of Building 771	NA

148/266

Table 2.2 (cont.)

LISTING OF IHSSs, PACs, and UBCs LOCATED WITHIN OPERABLE UNIT 8

Site No	Site Name	OU Number
	PACs (cont.)	
900-1301	Building 991 Enclosed Area	NA
900-1304	Chromic Acid Spill - Building 991	NA
900-1305	Building 991 Roof	NA
900-1306	Transformers 991-1 and 991-2	NA
900-1308	RO Plant Sludge Drying Beds	NA
	UBCs	
371	Building 371	NA
374	Building 374	NA
528	Building 528	NA
559	Building 559	NA
701	Building 701	NA
707	Building 707	NA
770	Building 770	NA
771	Building 771	NA
774	Building 774	NA
776	Building 776	NA
777	Building 777	NA
778	Building 778	NA
779	Building 779	NA

Source DOE, 1992

* = Exclusive of IHSSs included in RI activities planned in this Work Plan (see Table 2 1)

TABLE 2.3
BACKGROUND CONCENTRATIONS FOR ROCKY FLATS ALLUVIUM

Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium[1]	Cesium	Chromium[1]	Cobalt	Copper[1]	Iron	Lead[1]	Lithium[1]
Upper Tolerance Limit (mg/kg)	13419 4947		4 2988	79 4928	4 7040	--	8430 1986	--	19 9897	--	11 1314	13753.5715	12 1546	
Maximum Concentration (mg/kg)	40800.0	33.2U	41 7	209 0	19 0	3.2	157000 0	968.0U	69 6	28 1	16 6	33700 0	25 7	31 3

	Magnesium	Manganese	Mercury[1]	Molybdenum[1]	Nickel[1]	Potassium	Selenium	Silver	Sodium	Strontium[1]	Thallium[1]	Tin[1]	Vanadium[1]	Zinc[1]
Upper Tolerance Limit (mg/kg)	2484.2373	234 9950	--		21 4229	1557 9829	--		--		--	--	37 1857	39 7143
Maximum Concentration (mg/kg)	5570 0	656 0	0.32	41.0	54.2	4020 0	12 0U	40 9	4840 0U	226	5 4U	312.0	70 0	77 6

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite[1]	Sulfate
Upper Tolerance Limit (mg/kg except pH)		--	--		9 5174	--	
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	6 3858	NA	NA
Maximum Concentration (mg/kg except pH)					9 1	4 3	
Minimum Concentration (mg/kg except pH)					7 0	NA	NA

Radionuclides

	Americium-241	Cesium-137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium[2]	Uranium 233,234	Uranium-235	Uranium -238
Upper Tolerance Limit (pCi/g)	0 0135	0 0669	39 3636	36 8150	0.0150	0 6513	1 9561	0.7256	0.4147	0 6558	0 0741	0 6830
Maximum Concentration (pCi/g)	0 01	0.2	42 0	44 0	0.02	0 9	2.2	1 2	0 44	3 4	0 1	3 2

NA = Not applicable -- = Value not calculated U = Concentration below detection limit [1] Value for North Rocky Flats Alluvium [2] Concentration in pCi/ml

TABLE 2.4
BACKGROUND CONCENTRATIONS FOR COLLUVIUM, WEATHERED CLAYSTONE AND WEATHERED SANDSTONE

Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium[1]	Cesium	Chromium[1]	Cobalt	Copper[1]	Iron	Lead[1]	Lithium[1]
Upper Tolerance Limit (mg/kg)	10427 7752	..	4 0203	121 8903	3 4013	..	7566.5613	..	10 3477	..	16.2533	14726 3649	18 6811	11 6003
Maximum Concentration (mg/kg)	22900 0	16.2	10 8	491 0	10 3	2.6U	44300 0	516 0U	21 3	29 7	26 7	38100 0	28 2	48 4U

	Magnesium	Manganese	Mercury[1]	Molybdenum[1]	Nickel[1]	Potassium	Selenium	Silver	Sodium	Strontium[1]	Thallium[1]	Tin[1]	Vanadium[1]	Zinc[1]
Upper Tolerance Limit (mg/kg)	2799 1426	203.0125	..	13 4310	20 1842	..	..		..	64 0675	..		23 7320	62 3409
Maximum Concentration (mg/kg)	5580 0	737 0	0 44	48 4U	62 4	3090.0	12.8U	33.5	3680 0	113 0	5 0U	441 0	40 9	129 0

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite[1]	Sulfate
Upper Tolerance Limit (mg/kg except pH)	..	..	..	..	9 5161		..
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	7 2914	NA	NA
Maximum Concentration (mg/kg except pH)					9 7	2.5	
Minimum Concentration (mg/kg except pH)					7 2	NA	NA

Radionuclides

	Americium-241	Cesium-137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium[2]	Uranium -233,234	Uranium-235	Uranium -238
Upper Tolerance Limit (pCi/g)	..	0 0745	48 4255	34 1512	0 0209	1 1379	2.0537	0 6719	0 2875	0 9830	0 1756	1 0429
Maximum Concentration (pCi/g)		0.2	48 0	34 0	0.02	1 3	2.1	0 8	0 39	2.6	0 3	2.3

NA = Not applicable .. = Value not calculated U = Concentration below detection limit [1] Value for North Rocky Flats Samples [2] Concentration in pCi/ml

150/266

TABLE 2.5
BACKGROUND CONCENTRATIONS FOR UPPER MOST FLOW SYSTEM GROUNDWATER SAMPLES

Dissolved Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
Upper Tolerance Limit (mg/l)		--	--		--	--	62.5908		--	--				
Maximum Concentration (mg/l)	0.32	0 5U	0 01U	0 222	0 005U	0.0111	196.0	2.5U	0 02U	0.05U	0 0477	0.944	0 0396	0 4

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/l)	16 0851	0 2133				--	--	--	46 7359	--				
Maximum Concentration (mg/l)	179 0	0 686	0.0008	0.5U	0 0432	11 3	0 221	0 03U	714 0	7 12	0 05U	1 0U	0 05U	0 141

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride[1]	Cyanide	pH	Nitrate/ Nitrite	Sulfate
Upper Tolerance Limit (mg/l except pH)	249 3524	--	10.6716	--	8.2190	3 4338	67 0794
Lower Tolerance Limit (mg/l except pH)	NA	NA	NA	NA	6.3897	NA	NA
Maximum Concentration (mg/l except pH)	680 0	5 0U	28.0	0.01U	8 6	6.5	1800 0
Minimum Concentration (mg/l except pH)	NA	NA	NA	NA	6 3	NA	NA

Radionuclides

	Americium-241	Cesium-137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium	Uranium -233,234	Uranium-235	Uranium -238
Upper Tolerance Limit (pCi/l)	0 0167	0.5061	55 0708	59 6331	0 0150	96.2939	--	0.9004	359 0676		2.0862	25.5702
Maximum Concentration (pCi/l)	0.034	0.5	200 0	220 0	0 03	170.0		2.13	430.0	0 1	7 74	76 9

NA = Not applicable -- = Value not calculated U = Concentration below detection limit [1] Value for North Rocky Flats Upper Most Flow System

151/266

TABLE 2.6
BACKGROUND CONCENTRATIONS FOR LOWER MOST FLOW SYSTEM GROUNDWATER SAMPLES

Dissolved Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
Upper Tolerance Limit (mg/l)	..	..	..			..	49.2824	..	..	..	..	..		
Maximum Concentration (mg/l)	0.327	0 5U	0.0186	0 2U	0 005U	0 005U	167 0	2.5U	0 0177	0.05U	0 0695	0 0539	0 024	1 79

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/l)		..	..			..	..		231 8338	..				0 2234
Maximum Concentration (mg/l)	45 7	0 846	0 0003	0 5U	0.04U	21 9	0 041	0.03U	454 0	2.03	0 04U	1 0U	0 05U	0 374

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride[1]	Cyanide	pH	Nitrate/ Nitrite	Sulfate
Upper Tolerance Limit (mg/l except pH)	274 7981	28.6813	..	..	10 9077	6 4068	153 7200
Lower Tolerance Limit (mg/l except pH)	NA	NA	NA	NA	6.2443	NA	NA
Maximum Concentration (mg/l except pH)	390 0	25 0	230 0	0 01U	10 4	3 6	670 0
Minimum Concentration (mg/l except pH)	NA	NA	NA	NA	7 0	NA	NA

Radionuclides

	Americium-241	Cesium-137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium	Uranium -233,234	Uranium-235	Uranium -238
Upper Tolerance Limit (pCi/l)	0.0556	0.7837	25 3930	30 4997	0.0113	..		0 8554	420.4114	..	0 9438	6 2485
Maximum Concentration (pCi/l)	0.082	0 85	38 9	43 8	0 01	0.6		1 0	340 0		1 7	11.59

NA = Not applicable .. = Value not calculated U = Concentration below detection limit [1] Value for North Rocky Flats Lower Most Flow System

152/ 266

153/266

TABLE 2.7
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P209189

Sample Number	Sample Depth (feet)	Methylene Chloride (µg/kg)	Aluminum (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Calcium (mg/kg)	Lead (mg/kg)	Potassium (mg/kg)	Vanadium (mg/kg)	Gross Alpha (pCi/l)	Plutonium-239/240 (pCi/g)	Radium-226 (pCi/g)	Uranium-233,234 (pCi/g)	Uranium 238 (pCi/g)	Tritium (pCi/ml)
SEP1989BR0002	0.0-1 3	1AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR0002D	0.0-1 3(Dup.)	2AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR0003	0.0-3 0	NA	--	6	128	12400	17	1980	38	62	NA	0.8	1 9	1 0	0 49
SEP1989BR0309	3 0-9.5	NA	15400	14	48	--	--	3750	--	NA	NA	NA	NA	NA	NA
SEP1989BR0406	4.3-6 3	2AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR0810	8.3 9 5	2AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR1016	10 3-16.3	NA	--	9	ND	--	--	--	--	--	0.07	--	--	--	1 1
SEP1989BR1214	12 3-14 3	3AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR1618	16 3-18 3	3AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR1622	16 3-22.3	NA	--	5	--	--	--	--	--	--	0.04	--	--	--	1 4
SEP1989BR1622D	16 3-22.3(Dup.)	NA	--	--	--	--	--	ND	--	NA	NA	--	--	--	1 4
SEP1989BR2021	20 3-21 3	2AJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1989BR2223	22.3-23.3	7V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
ND = Not detected
-- = Constituent detected at concentration less than background

TABLE 2.8
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P209289

Sample Number	Sample Depth (ft)	1,1-Dichloro-ethene (ug/g) *	Acetone (ug/g) *	Benzene (ug/g) *	Chloro-benzene (ug/g) *	Chloro-form (ug/g) *	Methylene Chloride (ug/g) *	Toluene (ug/g) *	Trichloro-ethene (ug/g) *	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)
SEP20890002	0.0 - 1.2	ND	ND	ND	ND	ND	2 J	ND	ND	NA	NA	NA
SEP20890003	0 0 - 3 0	NA	NA	NA	NA	NA	NA	NA	NA	5	82	--
SEP20890309	3 0 9 2	NA	NA	NA	NA	NA	NA	NA	NA	6	91	--
SEP20890406	3 0 - 5 8	ND	ND	ND	ND	ND	2 J	ND	ND	NA	NA	NA
SEP20890810	7 8 - 9 2	ND	ND	ND	ND	ND	6	ND	ND	NA	NA	NA
SEP20890912	9 2 - 12 2	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
SEP20891214	11 8 - 12 2	2 J	8 J	2 J	2 J	8	6	2 J	2 J	NA	NA	NA
SEP20891418	13 8 - 17 8	NA	NA	NA	NA	NA	NA	NA	NA	7	--	7
SEP20891618	15 8 - 17 8	2 J	9 J	3 J	3 J	ND	8	3 J	3 J	NA	NA	NA

Sample Number	Sample Depth (ft)	Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Americium -241 (pCi/g)	Radium -226 (pCi/g)	Tritium (pCi/ml)	Uranium -233,-234 (pCi/kg)	Uranium -238 (pCi/g)	Nitrate/ Nitrite (mg/kg)
SEP20890002	0 0 - 1.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP20890003	0 0 - 3 0	12	--	249	--	42	0.15	0 7	1 1	0 7	--	19 AJ
SEP20890309	3 0 9 2	ND	--	456	--	--	0 03	--	1 0	--	--	11
SEP20890406	3 0 - 5 8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP20890810	7 8 - 9 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP20890912	9 2 12.2	--	--	238	--	--	ND	--	0 41	0 9	0 8	--
SEP20891214	11 8 12.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP20891418	13 8 17 8	25	28 400	--	61	91	ND	--	--	--	--	ND
SEP20891618	15 8 - 17 8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent detected at concentration less than background
ND = Not detected
* The units indicated for this constituent in RFEDS appear to be incorrect. This apparent discrepancy was not resolved during the preparation of this work plan.

154/266

155/266

TABLE 2.9
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL P209189

Sample Number	Sample Date	Carbon Tetrachloride (µg/l)	Chloroform (µg/l)	1,1-Dichloroethane (µg/l)	1,2-Dichloroethane (µg/l)	1,1-Dichloroethene (µg/l)	1,2-Dichloroethene (µg/l)	Perchloroethene (µg/l)	Trichloroethene (µg/l)	Calcium (mg/l)
GSEP19890989001	27-SEP-89	ND	2J	2J	2J	ND	ND	3J	8	81
GSEP19890989001D	27 SEP-89(Dup)	ND	3AJ	3AJ	ND	1AJ	ND	3AJ	8V	81
GSEP19890390001	02-MAR-90	ND	7	ND	ND	ND	7	14	28	115
SEP1989-0601-02-0830	01-JUN-90	ND	ND	ND	ND	ND	1J	2J	3J	68
GW00303IT	31-AUG-90	2J	2J	ND	ND	3J	ND	6	10	76
GW00617IT	08 NOV 90	1AJ	ND	2AJ	ND	2AJ	5V	4AJ	8V	76
GW01024IT	22-MAR 91	2AJ	ND	ND	ND	2AJ	7V	9V	15V	98
GW01389IT	06-JUN-91	ND	1J	ND	ND	ND	3J	4J	4J	65
GW01582IT	26-JUL-91	ND	ND	ND	ND	ND	ND	2J	3J	60
GW01814IT	10-OCT-91	ND	ND	ND	ND	ND	ND	ND	ND	70

Sample Number	Sample Date	Iron (mg/l)	Magnesium (mg/l)	Americium-241 (pCi/l)	Cesium-137 (pCi/l)	Plutonium-239/240 (pCi/l)	Radium-226 (pCi/l)	Tritium (pCi/l)
GSEP19890989001	27-SEP-89	ND	--	0 06	ND	0 34	NA	700
GSEP19890989001D	27 SEP-89(Dup)	ND	--	0 06	ND	0 34	NA	700
GSEP19890390001	02 MAR 90	--	20	0 08	1 04	0 06	NA	NA
SEP1989-0601-02-0830	01-JUN 90	1 5	--	--	ND	0 03	NA	--
GW00303IT	31-AUG-90	0 2	--	NA	NA	NA	NA	NA
GW00617IT	08-NOV-90	--	--	0 54	ND	3 56	2 6	619
GW01024IT	22-MAR-91	--	--	--	ND	0 23	--	782
GW01389IT	06-JUN 91	0 3	--	NA	ND	0 15	NA	NA
GW01582IT	26-JUL-91	0 5	--	--	ND	0 15	NA	--
GW01814IT	10-OCT 91	--	--	0 10	ND	0 44	NA	--

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
ND = Not detected
-- = Constituent detected at concentration less than background

TABLE 2.10
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2386

Sample Number	Sample Date	Carbon Tetrachloride (µg/l)	trans-1,2-Dichloroethene (µg/l)	Methylene Chloride (µg/l)	Trichloroethene (µg/l)	Calcium (mg/l)	Iron (mg/l)
23-86-03-18-87	18-MAR-87	ND	4	NA	ND	NA	NA
23-86-06-24-87	24-JUN-87	ND	ND	NA	ND	NA	NA
23-86-09-23-87	23-SEP 87	ND	5	NA	ND	NA	NA
23-86-01-15-88	15-JAN-88	7	NA	13	ND	96	–
23-86-03-21 88	21-MAR 88	ND	NA	16	ND	99	0 13
23 86-05-23-88	23-MAY-88	ND	NA	ND	ND	96	–
23-86-09-08-88	08-SEP-88	ND	NA	ND	ND	NA	NA
23-86-11 30-88	30-NOV 88	ND	NA	ND	ND	NA	NA
23 86-03-01 89	01 MAR 89	ND	ND	ND	ND	NA	NA
G23861189004	06-NOV 89	ND	NA	ND	ND	294	ND
G23860390001	22-MAR 90	ND	NA	ND	ND	94	0 45
G 2386-0524-02-0910	25 MAY-90	ND	NA	5B	ND	NA	NA
GW00616IT	14-NOV-90	ND	NA	ND	6V	NA	NA
GW01199IT	24-APR 91	ND	NA	ND	ND	100	–
GW01364IT	31-MAY 91	ND	NA	7	ND	NA	NA
GW01581IT	01-AUG 91	ND	NA	ND	ND	NA	NA
GW01815IT	07-OCT-91	ND	ND	ND	ND	NA	NA
GW02224IT	13-JAN 92	ND	NA	ND	ND	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
ND = Not detected
– = Constituent detected at concentration less than background

156/266

TABLE 2.11
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P218089

Sample Number	Sample Depth (ft)	Acetone (ug/kg)	Methylene Chloride (ug/kg)	Barium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)
OP03890002	0 0 - 1.2	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
OP03890003	0 0 3 0	NA	NA	--	8950	53	11	18	--	--	--
OP03890204	2 0 - 3 3	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
OP03890306	3 0 5 1	NA	NA	115	26,300	--	13	25	3950	40	47
OP03890406	4 0 - 5 1	5 AJ	ND	NA	NA	NA	NA	NA	NA	NA	NA
OP03890608	6 0 - 8 0	5 AJ	ND	NA	NA	NA	NA	NA	NA	NA	NA
OP03890610	8 0 10 0	NA	NA	538	15 800	--	13	13	4110	--	58
OP03890810	6 0 - 10 0	3 J	8 B	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

157/266

TABLE 2.12
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL P218089

Sample Number	Sample Date	Methylene Chloride (ug/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/ Nitrite (mg/l)	Sulfate (mg/l)	Uranium -233-234 (pCi/l)	Uranium -235 (pCi/l)	Uranium -238 (pCi/l)
GOP3890290001	14-Feb-90	NA	NA	NA	NA	NA	84	2.3	22
OP 0389-0529-02 1300	31 May 90	10	NA	NA	6 8	NA	45 6	0 8	14 97
GW01410IT	12 Jun 91	1 BJ	400	10	4	230	NA	NA	NA

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
– = Constituent present at concentration less than background

ND = Not detected

158/266

TABLE 2.13
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 1986

Sample Number	Sample Date	Acetone (µg/l)	1,1-Dichloroethene (µg/l)	trans-1,2-Dichloroethene (µg/l)	Methylene Chloride (µg/l)	Perchloro-ethene (µg/l)	1,1,1-Trichloroethane (µg/l)	Trichloroethene (µg/l)	Barium (mg/l)	Calcium (mg/l)	Iron (mg/l)	Magnesium (mg/l)
G-198609860	18 SEP-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19 86-03-26-87	26-MAR 87	ND	ND	4	ND	ND	ND	ND	0 23	214	ND	58
19 86-06 30-87	30 JUN-87	ND	ND	4	ND	ND	ND	ND	--	179	4	47
19 86-06 30-87FD	30-JUN 87	ND	ND	4	ND	ND	ND	ND	--	179	5	46
19-86-09-15-87	15 SEP-87	NA	ND	NA	NA	ND	ND	ND	--	124	4	38
19 86 12 18-87	18-DEC-87	ND	12	NA	13	10	5	8	--	127	4	36
19 86-03 16-88	16 MAR 88	5J	ND	NA	ND	ND	ND	ND	--	167	9	48
19 86-05 23-88	23 MAY-88	ND	ND	NA	ND	ND	ND	ND	--	151	5	46
19 86-09-07 88	07-SEP-88	ND	ND	NA	ND	ND	ND	ND	--	130	2	38
19 86-11 29 88	29 NOV-88	ND	ND	NA	ND	ND	ND	ND	--	121	5	34
19-86-02 27 8	27 FEB-89	ND	ND	ND	ND	ND	ND	ND	--	127	5	38
19 86-05 15 8	15-MAY-89	ND	ND	ND	ND	ND	ND	9 V	--	176	7	48
19-86-08-28 89	28 SEP 89	ND	ND	ND	ND	ND	ND	ND	--	165	6	44
G1986-1189004	03-NOV-89	21AJ	ND	ND	ND	ND	ND	21 AJ	ND	129	12	40
G19860290001	12 FEB 90	ND	ND	NA	ND	ND	ND	ND	ND	137	13	38
G19860290001D	12 FEB 90	ND	ND	NA	ND	ND	ND	ND	ND	135	13	38
G-1986-0509-02 1000	09 MAY-90	ND	ND	NA	3JB	ND	ND	ND	0 23	170	19	51
GW00054IT	25 JUL-90	13	ND	NA	8B	ND	ND	ND	--	153	13	48
GW00530IT	18 OCT 90	ND	ND	NA	ND	ND	ND	ND	--	130	9	38
GW01377IT	03 JUN 91	ND	ND	NA	1JB	ND	ND	ND	--	157	12	47
GW01583IT	31-JUL-91	ND	ND	NA	ND	ND	ND	ND	--	144	12	44
GW1800IT	02 OCT-91	ND	ND	ND	ND	ND	ND	ND	--	123	11	36
GW02200IT	30 JAN 92	ND	ND	NA	ND	ND	ND	ND	--	134	11	39

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J = Detected at concentration less than detection limit
-- = Constituent detected at concentration less than background

ND = Not detected

159/266

TABLE 2.13 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 1986

Sample Number	Sample Date	Manganese (mg/l)	Nickel (mg/l)	Sodium (mg/l)	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Plutonium -239/240 (pCi/l)	Strontium -89, -90 (pCi/l)	Tritium (pCi/l)	Uranium 233 -234 (pCi/l)
G-198609860	18-SEP-86	NA	NA	NA	NA	NA	NA	NA	NA	NA
19-86-03-26-87	26-MAR-87	4	ND	230	102	100	ND	3 5	ND	2 4
19 86-06-30-87	30-JUN-87	3	--	205	--	62	ND	ND	ND	0 96
19-86-06-30-87FD	30-JUN-87	3	--	204	--	--	ND	ND	ND	4 1
19 86-09-15 87	15-SEP-87	3	ND	174	ND	ND	8 5	1 4	ND	5 4
19 86-12 18 87	18-DEC 87	3	ND	178	--	ND	ND	NA	ND	5 5
19 86-03-16-88	16-MAR-88	3	0 05	221	--	ND	ND	NA	ND	5 8
19 86-05-23-88	23-MAY-88	3	ND	183	--	--	ND	NA	ND	5 0
19 86-09-07-88	07-SEP-88	3	ND	189	ND	ND	ND	NA	ND	5 0
19 86-11 29-88	29-NOV-88	3	ND	183	ND	ND	ND	NA	ND	4 9
19 86-02-27-8	27 FEB-89	3	ND	180	--	--	NA	NA	ND	NA
19 86-05 15-8	15 MAY-89	4	ND	202	--	--	NA	NA	NA	NA
19-86-08-28-89	28-SEP-89	3	ND	216	--	--	ND	NA	NA	4 40
G1986-1189004	03-NOV-89	3	ND	200	--	--	0 02	--	--	2 99
G19860290001	12 FEB-90	3	ND	--	--	--	--	--	--	4 27
G19860290001D	12 FEB-90	3	ND	171	ND	--	--	--	--	3 22
G 1986-0509-02-1000	09-MAY-90	4	ND	230	--	--	ND	--	520	4 51
GW00054IT	25-JUL-90	3	ND	392	--	--	ND	1 9	ND	3 78
GW00530IT	18-OCT-90	3	ND	182	ND	--	ND	ND	--	2 89
GW01377IT	03 JUN-91	3	ND	218	ND	--	ND	--	--	5 47
GW01583IT	31-JUL-91	3	ND	214	ND	--	ND	1 3	ND	2 85
GW01800IT	02-OCT-91	3	ND	187	--	--	ND	0 9	ND	3 47
GW02200IT	30-JAN-92	3	--	193	NA	NA	NA	NA	NA	NA

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A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent detected at concentration less than background

ND = Not detected

160/266

TABLE 2.13 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 1986

Sample Number	Sample Date	Bicarbonate (mg/l)	Chloride (mg/l)	Sulfate (mg/l)
G-198609860	18-SEP 86	NA	140	230
19-86-03-26-87	26 MAR 87	630	144	235
19 86-06-30-87	30-JUN 87	591	127	143
19-86-06-30-87FD	30 JUN-87	592	127	175
19 86-09-15 87	15 SEP-87	647	110	193
19 86-12-18 87	18 DEC 87	713	86	93
19-86-03-16-88	16 MAR 88	386	120	150
19 86-05-23 88	23 MAY-88	592	118	285
19 86-09-07-88	07 SEP 88	334	821	156
19 86-11-29-88	29 NOV-88	578	88	ND
19-86-02-27-8	27 FEB-89	750	79	--
19 86-05 15 8	15-MAY-89	632	225	--
19 86-08-28 89	28 SEP-89	599	118	174
G1986-1189004	03-NOV-89	790	88	120
G19860290001	12 FEB-90	890	120	110
G19860290001D	12 FEB-90	900	110	110
G 1986-0509-02 1000	09 MAY 90	610	170	236
GW00054IT	25-JUL-90	620	120	206
GW00530IT	18 OCT 90	610	110	130
GW01377IT	03 JUN 91	340	130	150
GW01583IT	31 JUL-91	670	130	140
GW1800IT	02 OCT 91	670	100	120
GW02200IT	30 JAN 92	620	170	170

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J = Detected at concentration less than detection limit
-- = Constituent detected at concentration less than background
ND = Not detected

161/266

TABLE 2.14
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2186

Sample Number	Sample Date	Acetone (µg/l)	Carbon Tetrachloride (µg/l)	Methylene Chloride (µg/l)	Trans-1,2-Dichloroethene (µg/l)	Aluminum (mg/l)	Calcium (mg/l)	Chromium (mg/l)	Iron (mg/l)	Magnesium (mg/l)	Nickel (mg/l)
21 86-03-25-87	25 MAR 87	NA	ND	NA	4	ND	62	ND	ND	ND	ND
21 86-06 29 87	29 JUN 87	NA	ND	NA	4	ND	–	ND	ND	–	0 04
21 86-09 15-87	15-SEP-87	NA	NA	NA	NA	–	–	ND	–	–	0 04
21 86-01-05 88	05-JAN 88	ND	8	8	NA	ND	52	ND	–	–	ND
21 86-03 21 88	21-MAR-88	ND	ND	17	ND	0 4	–	ND	0 07	–	ND
21 86 11 29 88	29 NOV 88	ND	ND	4 BJ	ND	–	51	ND	–	–	ND
21 86-03-06 89	06-MAR 89	ND	ND	5 BJ	ND	–	–	–	ND	–	ND
21 86-08 28 89	28-AUG-89	ND	ND	ND	ND	–	50	ND	ND	–	ND
G2 1861 189-004	07 NOV-89	ND	ND	ND	NA	–	–	ND	ND	–	ND
G2186-029-0001	28-FEB-90	ND	ND	3 JB	NA	–	–	ND	ND	–	ND
G 21860510-02 1023	11 MAY-90	ND	ND	NA	NA	–	–	ND	ND	–	ND
GW00059IT	02-AUG-90	5 BJ	ND	2 J	NA	–	–	–	NA	–	NA
GW01379IT	04-JUN-91	ND	ND	1 BJ	NA	ND	–	ND	NA	–	ND
GW01637IT	09-AUG-91	7 J	ND	ND	NA	–	–	–	–	–	ND
GW01893IT	16-OCT 91	ND	ND	4 BJ	NA	–	–	–	–	–	ND
GW02255IT	29-JAN 92	ND	ND	ND	NA	–	–	0 08	4 3	0 09	0 06

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B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
– = Constituent present at concentration less than background
ND = Not detected

162/266

TABLE 2.14 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2186

Sample Number	Sample Date	Zinc (mg/l)	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Plutonium-239/240 (pCi/l)	Radium-226 (pCi/l)	Strontium-89 -90 (pCi/l)	Uranium-235 (pCi/l)	Bicarbonate (mg/l)	Sulfate (mg/l)
21-86-03 25-87	25-MAR-87	ND	27	33	0 73	NA	2 51	--	--	--
21 86-06 29 87	29 JUN 87	ND	28	--	ND	NA	ND	--	--	--
21 86-09 15-87	15 SEP 87	ND	--	--	ND	NA	ND	--	--	--
21 86-01-05 88	05 JAN 88	ND	--	--	ND	NA	ND	--	--	--
21-86-03-21 88	21-MAR 88	--	--	--	ND	NA	NA	--	--	--
21 86 11 29 88	29 NOV 88	ND	--	ND	ND	NA	NA	--	NA	NA
21 86-03-06-89	06-MAR-89	0 03	--	--	NA	NA	NA	--	NA	NA
21-86-08 28-89	28-AUG-89	ND	--	--	--	NA	NA	--	--	--
G2-1861 189-004	07 NOV-89	--	--	--	0 02	NA	--	--	--	--
G2186-029-0001	28-FEB 90	ND	--	--	--	NA	--	NA	--	--
G 21860510-02-1023	11 MAY 90	--	NA	NA	NA	NA	NA	NA	--	6 820
GW00059IT	02 AUG-90	NA	--	--	--	0 34	--	0 05	--	--
GW01379IT	04-JUN 91	ND	--	--	ND	NA	--	--	400	--
GW01637IT	09-AUG 91	NA	--	--	ND	NA	--	--	--	--
GW01893IT	16-OCT 91	--	NA	NA	NA	NA	NA	NA	--	--
GW02255IT	29 JAN 92	--	NA	NA	NA	NA	NA	NA	--	--

Sheet 2 of 2

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-- = Constituent present at concentration less than background
ND = Not detected

163/266

TABLE 2.15
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2586

Sample Number	Sample Date	Acetone (ug/l)	Benzene (ug/l)	2 Butanone (ug/l)	Carbon Tetra-chloride (ug/l)	Chloro-benzene (ug/l)	Ethyl benzene (ug/l)	Trans-1,2-Dichloro-ethene (ug/l)	cis-1,3-Dichloro-propene (ug/l)	Methylene Chloride (ug/l)	Styrene (ug/l)	Toluene (ug/l)
25 86-03 18-87	18-Mar-87	ND	ND	ND	ND	ND	ND	4	ND	ND	ND	ND
25 86-06-24-87	24 Jun-87	ND	ND	ND	ND	ND	ND	4	ND	ND	ND	ND
25 86-08 28-87	28-Aug 87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 86-01 15 88	15-Jan-88	ND	ND	ND	7	ND	ND	ND	ND	ND	ND	ND
25 86-03 21-88	21 Mar-88	ND	ND	ND	ND	ND	ND	ND	ND	17	ND	ND
25 86-05 18-88	18-May 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 86-09 13-88	13-Sep-88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 86-12-06-88	06-Dec-88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 86-03-06 89	06-Mar 89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 86-05-17-89	17 May 89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 86-08 29-89	28-Aug 89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G25861189004	08-Nov 89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G25860290001	22-Feb-90	ND	ND	ND	ND	ND	ND	ND	ND	3 JB	ND	ND
G25860524021140	25-May-90	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GW00293IT	28-Aug 90	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GW00471IT	11-Oct 90	7 JB	11 J	4 JB	ND	ND	ND	ND	1 J	3 JB	ND	ND
GW0847IT	08 Jan-91	ND	5 AJ	ND	ND	5 AJ	5 AJ	ND	5	1 A	5 AJ	5 AJ
GW01397IT	11-Jun-91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GW01600IT	24-Jul 91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GW02267IT	23-Jan-92	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sheet 1 of 3

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164/266

TABLE 2.15 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2586

Sample Number	Sample Date	Total Xylenes (ug/l)	Calcium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Magnesium (mg/l)	Nickel (mg/l)	Sodium (mg/l)	Strontium (mg/l)
25 86-03-18-87	18-Mar-87	ND	192	ND	ND	ND	77	0 13	247	2.57
25 86-06 24-87	24-Jun-87	ND	268	ND	ND	ND	107	--	307	3 20
25 86-08-28-87	28-Aug-87	NA	209	--	--	ND	101	0 10	280	3 10
25 86-01-15-88	15-Jan-88	ND	234	0 04	--	--	100	0 08	283	3 15
25 86-03 21-88	21-Mar 88	ND	207	--	--	0 08	85	ND	259	3 04
25 86-05 18 88	18-May 88	NA	196	ND	--	ND	96	ND	--	--
25 86-09 13-88	13-Sep-88	NA	210	0 03	ND	--	96	ND	296	3 58
25 86-12-06-88	06 Dec-88	NA	249	ND	ND	0.09	93	ND	296	3 38
25 86-03-06-89	06-Mar 89	NA	271	--	--	0 15	112	ND	347	3 78
25 86-05 17 89	17-May-89	NA	235	ND	0 01	ND	96	0 04	297	3 30
25 86-08 29 89	28-Aug 89	NA	246	--	ND	ND	89	0 08	285	3 17
G25861189004	08-Nov 89	NA	227	ND	ND	ND	93	ND	276	2.87
G25860290001	22-Feb-90	ND	227	ND	ND	ND	97	ND	302	3 03
G25860524021140	25-May-90	NA	221	ND	ND	ND	93	ND	294	3 05
GW00293IT	28-Aug-90	NA	237	0 04	--	NA	95	NA	261	2 97
GW00471IT	11-Oct 90	2 J	240	0 03	--	0 09	93	--	279	2 96
GW0847IT	08-Jan-91	ND	241	0 03	NA	NA	91	NA	298	3 00
GW01397IT	11-Jun-91	NA	234	NA	ND	NA	94	NA	299	3 13
GW01600IT	24-Jul 91	NA	232	0 03	ND	NA	93	NA	299	2 95
GW02267IT	23 Jan-92	ND	245	ND	ND	NA	97	ND	285	3 16

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-- = Constituent present at concentration less than background

ND = Not detected

165/266

TABLE 2.15 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2586

Sample Number	Sample Date	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Plutonium 239/240 (pCi/l)	Radium -226 (pCi/l)	Strontium -89, -90 (pCi/l)	Uranium 238 (pCi/l)	Bicarbonate (mg/l)	Sulfate (mg/l)
25-86-03-18-87	18-Mar-87	140	116	ND	NA	1 8	7 0	410	1100
25 86-06-24-87	24-Jun-87	--	ND	ND	NA	2 3	--	390	400
25-86-08-28 87	28-Aug-87	--	54	ND	NA	ND	--	407	1060
25-86-01 15 88	15-Jan-88	ND	--	ND	NA	ND	--	437	1030
25-86-03-21-88	21 Mar-88	ND	ND	NA	NA	NA	--	--	1050
25 86-05 18-88	18-May 88	--	--	ND	NA	NA	--	373	1355
25 86-09 13 88	13 Sep-88	--	--	ND	NA	NA	--	NA	NA
25 86-12-06-88	06-Dec 88	ND	ND	NA	NA	NA	--	NA	NA
25 86-03-06 89	06-Mar 89	--	80	NA	NA	NA	NA	459	--
25 86-05 17 89	17 May 89	ND	ND	NA	NA	NA	--	413	1180
25 86-08 29 89	28 Aug 89	--	--	NA	NA	NA	--	368	1110
G25861189004	08 Nov 89	--	--	0 02	NA	ND	--	540	1000
G25860290001	22 Feb-90	--	--	0 03	NA	--	--	520	1200
G25860524021140	25-May-90	--	--	ND	NA	ND	NA	412	1120
GW00293IT	28 Aug 90	NA	NA	NA	NA	NA	NA	430	1100
GW00471IT	11 Oct 90	--	30	NA	0 64	NA	--	420	1300
GW0847IT	08 Jan-91	NA	--	NA	NA	NA	NA	410	1300
GW01397IT	11 Jun-91	ND	--	ND	NA	NA	--	-	1600
GW01600IT	24-Jul 91	ND	NA	NA	NA	NA	--	410	1000
GW01909IT	16-Oct 91	NA	NA	NA	NA	NA	NA	410	1500
GW02267IT	23-Jan-92	NA	NA	NA	NA	NA	NA	410	1200

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J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

166/266

167/266

TABLE 2.16
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P207589

Sample Number	Sample Depth (ft)	Acetone (µg/g) *	2 Butanone (µg/g) *	Methylene Chloride (µg/g) *	4-Methyl-2-Pentanone (µg/g) *	Arsenic (mg/kg)	Barium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)
SEP0389BR0002	0 0 - 2 1	ND	ND	4 J	ND	NA	NA	NA	NA
SEP0389BR0003	0 0 - 3 0	NA	NA	NA	NA	–	193	115 000	–
SEP0389BR0309	3 0 - 9 4	NA	NA	NA	NA	ND	155	93 500	–
SEP0389BR0406	4 1 - 5 4	ND	ND	7 B	2 JB	NA	NA	NA	NA
SEP0389BR0810	8 1 - 9 7	14 B	ND	6 B	ND	NA	NA	NA	NA
SEP0389BR0915	9 4 - 15 4	NA	NA	NA	NA	17	128	8560	11
SEP0389BR1214	12 1 - 14 1	12 JB	ND	6 B	ND	NA	NA	NA	NA
SEP0389BR1521	15 4 - 21 4	NA	NA	NA	NA	–	ND	–	–
SEP0389BR1618	16 1 - 18 1	12 B	ND	6 B	ND	NA	NA	NA	NA
SEP0389BR2022	20 1 - 22.1	ND	2 J	6 B	2 JB	NA	NA	NA	NA

Sample Number	Sample Depth (ft)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Nickel (mg/kg)	Strontium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Nitrate/ Nitrite (mg/kg)
SEP0389BR0002	0.0 - 2 1	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP0389BR0003	0.0 - 3 0	–	–	14	4,020	–	237	–	–	16 V
SEP0389BR0309	3 0 - 9 4	–	–	–	–	ND	354	–	–	13 V
SEP0389BR0406	4 1 - 5 4	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP0389BR0810	8 1 - 9 7	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP0389BR0915	9 4 - 15 4	24	30 500	–	4 030	43	ND	46	124	22 V
SEP0389BR1214	12 1 - 14 1	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP0389BR1521	15 4 - 21 4	17	–	25	–	–	ND	–	–	–
SEP0389BR1618	16 1 - 18 1	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP0389BR2022	20 1 - 22 1	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid　　A = Validated and valid with qualifiers　　J = Detected at concentration less than detection limit　　ND = Not detected
NA = Not analyzed　　B = Constituent detected in laboratory blank　　– = Constituent present at concentration less than background
* = The units indicated for this constituent in RFEDS appear to be incorrect. This apparent discrepancy was not resolved during the preparation of this work plan.

TABLE 2.17
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P209089

Sample Number	Sample Depth (ft)	Acetone (g/g)*	Methylene Chloride (g/g)*	Aluminum (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Mercury (mg/kg)
SEP1889BR0002	0.0 1.5	ND	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR0002D	0 1.5 (Dup)	ND	4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR0003	0.0 3.2	NA	NA	--	--	12	24,300	--	--	--	--		0.4
SEP1889BR0309	3.5 8.6	NA	NA	17 300	196	60	80 800	--	--	36	3 730	269	ND
SEP1889BR0406	3.5 5.2	ND	2 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR0810	7.5 8.6	5 J	1 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR1214	11.5 13.5	4 J	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR1218	11.5 - 17.5	NA	NA	--	--	ND	--	--	--	ND	--	--	ND
SEP1889BR1218D	11.5 - 17.5 (Dup)	NA	NA	--	--	ND	--	19	22	--	3 020	--	ND
SEP1889BR1618	15.5 17.5	ND	17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR1824	17.25 23.5	NA	NA	--	ND	ND	--	--	20	ND	--		--
SEP1889BR2022	19.5 21.5	ND	13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR2426	23.5 - 25.5	ND	5J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentrations less than background

ND = Not detected

* The units indicated for this constituent in RFEDS appear to be incorrect. This apparent discrepancy was not resolved during the preparation of this work plan.

168/266

TABLE 2.17 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P209089

Sample Number	Sample Depth (ft)	Potassium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Americium 241 (pCi/g)	Plutonium-239 (pCi/g)	Radium-226 (pCi/g)	Tritium (pCi/ml)	Uranium-233, -234 (pCi/g)	Uranium-235 (pCi/g)	Uranium 238 (pCi/g)	Nitrate/Nitrite (mg/kg)
SEP1889BR0002	0.0 - 1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR002D	0 0 1 5(Dup)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR0003	0 0 3 2	ND	--	--	0 8	1 6	0 9	--	ND	ND	ND	--
SEP1889BR0309	3 5 8 6	2,370	--	--	--	0.2	0 7	0 9	--	ND	--	--
SEP1889BR0406	3 5 5 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR0810	7 5 - 8 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR1214	11.5 13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR1218	11 5 - 17.5	--	--	--	ND	ND	0 7	4 3	1 4	0 2	1 3	--
SEP1889BR1218D	11 5 - 17.5 (Dup)	ND	24	--	ND	0.1	--	4 0	1 0	ND	1 1	158
SEP1889BR1618	15.5 - 17.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR1824	17.5 - 23.5	ND	--	101	ND	ND	--	ND	1 3	ND	1 1	182
SEP1889BR2022	19 5 - 21.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP1889BR2426	23 5 - 25.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentrations less than background

ND = Not detected

* The units indicated for this constituent in RFEDS appear to be incorrect. This apparent discrepancy was not resolved during the preparation of this work plan.

169/266

TABLE 2.18
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL P209089

Sample Number	Sample Date	Acetone (g/l)	Chloroform (g/l)	Ethylbenzene (g/l)	Methylene Chloride (g/l)	Toluene (g/l)	Total Xylenes (g/l)	Calcium (mg/l)	Gross Alpha (pCi/l)	Uranium 238 (pCi/l)	Bicarbonate (mg/l)	Sulfate (mg/l)
GSEP18890989001	26-SEP 89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GSEP18890390001	05 MAR-90	ND	ND	ND	5 B	ND	ND	50	31	NA	420	--
SEP1889 0507 02 1000	08 MAY 90	ND	ND	3 J	3 JB	1 J	12	NA	NA	NA	NA	NA
GW00042IT	31 JUL-90	8 JB	ND	ND	4 JB	ND	ND	NA	NA	NA	NA	NA
GW00502IT	16-OCT 90	ND	ND	ND	ND	ND	ND	NA	52	19	NA	NA
GW01035IT	26-MAR 91	13 AJ	5 V	ND	1 AJ	ND	ND	NA	--	18	340	--
GW01424IT	13-JUN-91	ND	ND	ND	ND	ND	ND	NA	NA	NA	310	170
GW01634IT	02 AUG-91	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA
GW01913IT	23-OCT-91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GW02270IT	19 MAR 92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

170/266

TABLE 2.19
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2286

Sample Number	Sample Date	Acetone (g/l)	Carbon Tetrachloride (g/l)	Chloroform (g/l)	1,1-Dichloroethane (g/l)	1,2-Dichloroethane (g/l)	1,2-Dichloroethene (g/l)	trans-1, 2-Dichloroethene (g/l)	Methylene Chloride (g/l)	Perchloroethene (g/l)	1 1 1 Trichloroethane (g/l)
G228609860	09 SEP 86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22 86-03 24 87	24 MAR 87	NA	ND	100	NA	ND	28	28	NA	ND	1 400
22 86-06 24 87	24 JUN 87	NA	3 000	36	NA	8 000	ND	4 NA	NA	8	NA
22 86-08 28 87	28 AUG 87	NA	491	80	NA	NA	ND	NA	NA	ND	NA
22 86-12 18 87	18 DEC 87	4 J	161	38	ND	ND	ND	NA	10	ND	ND
22 86-03 16-88	16-MAR 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22 86-05 17 88	17 MAY 88	ND	233	103	ND	ND	ND	NA	ND	ND	ND
22-86-09-09-88	09-SEP 88	ND	NA	NA	ND	ND	ND	NA	NA	ND	ND
22 86-08 28 89	28-AUG 89	NA	65	ND	ND	ND	ND	NA	NA	ND	NA
G22861189004	06-NOV-89	NA	79 J	37 J	ND	ND	ND	ND	4 AJB	ND	ND
G22860290001	19 FEB 90	ND	500	97	ND	ND	20	ND	ND	ND	ND
G 2286-0509 02 1236	09 MAY 90	ND	850	110	ND	ND	30	ND	2 JB	2 J	ND
GW00183IT	27-JUL 90	ND	580	120	ND	29	ND	ND	ND	ND	14 J
GW00543IT	12 OCT 90	10 JB	260	76	10	ND	25	ND	4 JB	ND	ND
GW00840IT	07 JAN 91	5 JB	ND	120	ND	ND	50	ND	7	5	ND
GW01349IT	29-MAY 91	ND	800	120	ND	ND	30	ND	17 JB	6 J	ND
GW01577IT	30-JUL-91	27	ND	ND	ND	ND	ND	ND	11	ND	ND
GW01807IT	03 OCT 91	NA	670	130	ND	ND	ND	30	ND	7	ND
GW02205IT	10 JAN 92	ND	ND	61	ND	ND	17	ND	ND	4 J	ND

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

171/266

TABLE 2.19 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2286

Sample Number	Sample Date	Trichloroethene (g/l)	Aluminum (mg/l)	Antimony (mg/l)	Calcium (mg/l)	Chromium (mg/l)	Lead (mg/l)	Lithium (mg/l)	Magnesium (mg/l)	Manganese (mg/l)	Nickel (mg/l)
G228609860	09 SEP-86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22 86-03-24-87	24-MAR 87	650	--	ND	--	ND	ND	NA	--	--	--
22 86-06-24 87	24 JUN 87	6,000	0 03	ND	--	ND	--	NA	--	--	0 11
22 86-08 28 87	28 AUG 87	490	0 42	ND	--	ND	ND	NA	--	0 23	0 09
22 86-12 18 87	18 DEC 87	186	0 04	ND	65	--	NA	--	--	0 26	0 20
22 86-03-16-88	16-MAR 88	NA	--	ND	63	ND	NA	1 3	--	--	0 17
22 86-05 17 88	17 MAY 88	173	--	ND	78	ND	ND	NA	--	0 23	0 19
22 86-09-09 88	09 SEP 88	ND	--	ND	65	--	ND	NA	--	0 29	0 20
22 86-08 28 89	28 AUG 89	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
G22861189004	06-NOV 89	110	ND	0 06	81	ND	ND		--	--	0 05
G22860290001	19 FEB 90	430	ND	ND	102	ND	ND	--	17	ND	--
G 2286-0509-02 1236	09 MAY 90	600	ND	ND	104	ND	ND	--	--	ND	--
GW00183IT	27 JUL 90	640	ND	ND	95	ND	ND	--	--	NA	0 06
GW00543IT	12 OCT 90	310	NA	NA	104	--	ND	--	--	NA	--
GW00840IT	07 JAN 91	ND	NA	NA	100	--	--		--	NA	NA
GW01349IT	29 MAY 91	630	NA	NA	119	NA	ND	0 5	17	--	0 05
GW01577IT	30-JUL 91	ND	--	NA	106	--	ND	0 6	--	--	--
GW01807IT	03 OCT 91	620	--		112	--	ND	0 8	16	--	
GW02205IT	10-JAN 92	360	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

172/266

TABLE 2.19 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2286

Sample Number	Sample Date	Sodium (mg/l)	Americium -241 (pCi/l)	Cesium 137 (pCi/l)	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Plutonium 239/240 (pCi/l)	Strontium -89/90 (pCi/l)	Tritium (pCi/l)	Uranium-233, 234 (pCi/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/ Nitrite (mg/l)	Sulfate (mg/l)
G228609860	09 SEP 86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	37	100	75
22 86-03 24 87	24-MAR 87	185	ND	NA	–	–	4 6	1 85	–	9 2	–	47	6 8	81
22 86-06-24 87	24 JUN 87	146	ND	NA	109	109	–	ND	ND	9 1	317	48	–	–
22 86-08 28 87	28 AUG-87	129	ND	NA	–	–	ND	5 7	723	5 8	335	40	–	–
22 86-12-18-87	18 DEC 87	79	ND	NA	–	–	ND	ND	–	5 6	308	29	–	70
22 86-03 16-88	16-MAR 88	87	ND	NA	–	–	ND	NA	–	6 3	–	44		–
22 86-05 17 88	17 MAY-88	76	ND	NA	–	–	ND	NA	390	5 4	262	58		
22 86-09-09 88	09 SEP 88	85	0 05	NA	–	–	ND	NA	360	9 9	299	39	NA	NA
22 86-08 28-89	28 AUG-89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	–
G22861189004	06-NOV 89	57	–	ND	–	–	0.02	–	–	4 1	340	17	6 6	–
G22860290001	19 FEB 90	76	NA	ND	NA	NA	NA	–	NA	NA	370	80	9 1	–
G 2286-0509 02 1236	09 MAY 90	63	ND	ND	–	–	ND	ND	480	5 1	284	54	7 8	–
GW00183IT	27 JUL-90	62	–	–	–	–	0.12	–	457	5 4	300	45	7 2	–
GW00543IT	12 OCT 90		–	ND	–	–	–	0 20	397	4 7	320	38	4 3	–
GW00840IT	07 JAN 91	62	–	ND	–	–	ND	–	373	6 3	310	43	6 1	–
GW01349IT	29 MAY 91	62	NA	NA	NA	NA	NA	NA	NA	NA	300	70	13	74
GW01577IT	30 JUL 91	64	0.06	ND	–	–	0.38	1 98	383	4 1	340	57	8 7	–
GW01807IT	03-OCT 91	74	0 08	1 06	–	–	0 94	ND	482	3 9	350	48	7 7	–
GW02205IT	10-JAN 92	NA	NA	NA	NA	NA	NA	NA	NA	NA	330	53	10	82

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

173/266

174/266

TABLE 2.20
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 5687

Sample Number	Sample Date	Acetone (g/l)	Carbon Tetrachloride (g/l)	Chloroform (g/l)	1,1 Dichloro-ethane (g/l)	1 1-Dichloro-ethene (g/l)	1 2 Dichloro ethene (g/l)	trans-1,2-Dichloro-ethene (g/l)	1,2-Dichloro-propane (g/l)	Methylene Chloride (g/l)
56-87 03-16-88	16-Mar-88	ND	ND	6	6	4 J	ND	NA	ND	ND
59 87 05 23 88	23 May 88	ND	ND	ND	15	11	ND	NA	ND	ND
56 87 03-01 89-RR	01 Mar-89	ND	ND	ND	4 J	3 J	ND	ND	ND	ND
56 87 08 28 89	28 Aug 89	ND	ND	6	12	7	ND	ND	1 J	ND
G56871189004	20-Nov-89	ND	9	3 J	ND	6	ND	NA	ND	NA
G56870290001	15 Feb-90	17	ND	5	8	5	11	NA	ND	NA
G5687 0509-02 1425	10-May-90	ND	6	6	9	ND	13	NA	ND	3 JB
GW00055IT	31 Jul-90	8 JB	ND	6	10	7	16	NA	2 J	2 JB
GW00565IT	23 Oct 90	NA	ND	5	9	6	ND	NA	2 J	4 JB
GW0085IT	09 Jan-91	7 JB	ND	4 J	8	6	18	NA	1 J	ND
GW01348IT	30 May-91	ND	ND	5	10	6	15	NA	ND	ND
GW01808IT	04-Oct 91	ND	ND	5	10	6	ND	14	ND	ND
GW02203IT	10-Jan 92	ND	ND	4 J	7	ND	10	NA	ND	ND

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

TABLE 2.20 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 5687

Sample Number	Sample Date	Perchloro-ethene (g/l)	1,1,1 Tri-chloroethane (g/l)	Trichloro-ethene (g/l)	Vinyl Chloride (g/l)	Calcium (mg/l)	Copper (mg/l)	Lead (mg/l)	Mercury (mg/l)	Nickel (mg/l)
56-87-03 16-88	16-Mar-88	4 J	29	57	ND	NA	NA	NA	NA	NA
59 87-05 23 88	23 May 88	7	ND	124	ND	NA	NA	NA	NA	NA
56-87 03-01 89-RR	01 Mar-89	2 J	3 J	43	ND	NA	NA	NA	NA	NA
56-87 08 28 89	28 Aug 89	4 J	7	84	ND	NA	NA	NA	NA	NA
G56871189004	20 Nov 89	8	ND	67	ND	139	0 19	--	0 0003	0 164
G56870290001	15 Feb-90	3 J	ND	59	1 J	NA	NA	NA	NA	NA
G5687 0509 02 1425	10-May-90	2 J	5	74	ND	140	0 11	0 17	ND	0 063
GW00055IT	31 Jul-90	5	7	77	2 J	NA	NA	NA	NA	NA
GW00565IT	23-Oct 90	4 J	6	72	2 J	NA	NA	NA	NA	NA
GW0085IT	09 Jan 91	4 J	4 J	68	2 J	NA	NA	NA	NA	NA
GW01348IT	30-May-91	3 J	5	71	3 J	NA	NA	NA	NA	NA
GW01808IT	04 Oct 91	4 J	6	70	3 J	NA	NA	NA	NA	NA
GW02203IT	10-Jan 92	3 J	4 J	55	ND	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

175/266

TABLE 2.20 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 5687

Sample Number	Sample Date	Sodium (mg/l)	Zinc (mg/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/ Nitrite (mg/l)	Sulfate (mg/l)
56-87-03 16-88	16-Mar-88	NA	NA	NA	NA	NA	NA
59 87 05 23 88	23 May 88	NA	NA	NA	NA	NA	NA
56-87 03-01 89-RR	01 Mar-89	NA	NA	NA	NA	NA	NA
56 87 08 28 89	28 Aug 89	NA	NA	NA	NA	NA	NA
G56871189004	20-Nov 89	271	1 5	--	54	--	--
G56870290001	15 Feb-90	NA	NA	410	53	NA	130
G5687 0509-02 1425	10-May 90	287	0.6	--	58	98	6960
GW00055IT	31 Jul 90	NA	NA	400	57	NA	170
GW00565IT	23-Oct 90	NA	NA	NA	NA	NA	NA
GW0085IT	09 Jan 91	NA	NA	NA	NA	95	NA
GW01348IT	30-May 91	NA	NA	340	43	90	160
GW01808IT	04 Oct 91	NA	NA	390	55	87	240
GW02203IT	10-Jan 92	NA	NA	370	66	77	210

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

176/266

TABLE 2.21
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL P210189

Sample Number	Sample Date	Acetone (g/l)	Bromomethane (g/l)	Carbon Disulfide (g/l)	Carbon Tetrachloride (g/l)	Chloroform (g/l)	Chloromethane (g/l)	1,1-Dichloroethane (g/l)	1 1-Dichloroethene (g/l)	1 2 Dichloroethane (g/l)
GSEP30890989001	28 SEP-89	ND	7 J	ND	ND	ND	4 J	ND	ND	ND
GSEP30890390001	01-MAR 90	680 J	ND	ND	ND	400	ND	ND	120	ND
GSEP30890390001D	01-MAR 90	ND	ND	ND	13,000	ND	ND	ND	ND	ND
SEP3089-0608-02-1410	08 JUN 90	ND	ND	ND	ND	ND	ND	1 J	8	2 J
GW00268IT	17-AUG 90	8 JB	ND	4 J	ND	ND	ND	ND	8	3 J
GW0066IT	09 NOV-90	ND	ND	ND	ND	ND	ND	ND	8	ND
GW01346IT	26 MAR-91	ND	ND	ND	ND	420	ND	ND	ND	ND
GW01344IT	29 MAY-91	110 J	ND	ND	ND	470	ND	ND	ND	ND
GW01632IT	06-AUG-91	ND	ND	ND	16 000	730	ND	ND	ND	ND
GW01908IT	14-OCT-91	ND	ND	ND	ND	390	ND	ND	ND	ND
GW02257IT	20-JAN-92	ND	ND	ND	ND	ND	ND	ND	7	3 J

Sample Number	Sample Date	1,2-Dichloroethene (g/l)	Methylene Chloride (g/l)	Perchloroethene (g/l)	1,1,2-Trichloroethane (g/l)	Trichloroethene (g/l)	Vinyl Chloride (g/l)	Aluminum (mg/l)	Barium (mg/l)	Calcium (mg/l)
GSEP30890989001	28 SEP 89	ND	ND	ND	ND	ND	ND	ND	0 22	130
GSEP30890390001	01 MAR 90	ND	78 JB	ND	ND	ND	ND	NA	NA	115
GSEP30890390001D	01 MAR 90	ND	ND	ND	ND	5 800	ND	NA	NA	105
SEP3089-0608 02 1410	08 JUN 90	150	4 JB	8	ND	5,300	ND	513	ND	122
GW00268IT	17 AUG-90	160	5	9	1 J	ND	3 J	NA	NA	126
GW0066IT	09 NOV 90	200	ND	13	ND	ND	2 J	NA	NA	117
GW01346IT	26-MAR 91	ND	ND	ND	ND	6,800	ND	NA	NA	114
GW01344IT	29 MAY 91	260	130 JB	ND	ND	5 600	ND	NA	NA	118
GW01632IT	06-AUG 91	ND	ND	ND	ND	7,900	ND	NA	NA	114
GW01908IT	14 OCT 91	77 J	ND	ND	ND	ND	ND	--	NA	115
GW02257IT	20-JAN 92	160	2 J	9	ND	ND	3 J	635	NA	122

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

177/266

TABLE 2 21 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN GROUNDWATER SAMPLES FROM WELL P210189

Sample Number	Sample Date	Chromium (mg/l)	Iron (mg/l)	Mercury (mg/l)	Plutonium-239/240 (pCi/l)	Radium-226 (pCi/l)	Strontium-89,90 (pCi/l)	Tritium (pCi/l)	Bicarbonate (mg/l)	Nitrate/Nitrite (mg/l)
GSEP30890989001	28-SEP-89	ND	ND	ND	0 01	NA	ND	1,150	350	38
GSEP30890390001	01 MAR-90	ND	NA	NA	ND	NA	NA	NA	340	27
GSEP30890390001D	01-MAR-90	ND	NA	ND	ND	NA	NA	NA	340	29
SEP3089-0608-02-1410	08-JUN-90	ND	ND	ND	ND	NA	NA	NA	280	--
GW00268IT	17-AUG-90	ND	ND	0 0005	0 04	0 79	18 6	1,320	280	22
GW0066IT	09 NOV-90	ND	NA	--	0 02	--	--	1,095	--	11
GW01346IT	26-MAR-91	NA	NA	0 0004	--	NA	--	1,116	290	26
GW01344IT	29 MAY-91	NA	NA	ND	NA	NA	NA	NA	280	22
GW01632IT	06-AUG-91	ND	0 8	ND	ND	NA	ND	1,143	280	16
GW01908IT	14-OCT-91	--	1 6	ND	NA	NA	NA	NA	280	21
GW02257IT	20-JAN-92	0 012	1 1	ND	NA	NA	NA	NA	280	34

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

178/266

179/266

TABLE 2.22
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P210189

Sample Number	Sample Depth (ft)	Acetone (ug/kg)	Methylene Chloride (ug/kg)	Toluene (ug/kg)	Aluminum (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)
SEP3089BR0002	0 0 - 2 3	64 AJB	540 AJB	ND	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0003	0 0 - 3 0	NA	NA	NA	21,100	4	228	4	--		
SEP3089BR0309	3 0 - 9 0	NA	NA	NA	23,000	--	82	--	--	--	--
SEP3089BR0406	4 6 - 6 6	800 AJB	480 AJB	ND	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0810	8 6 - 9 4	ND	380 AJ	ND	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0915	9 0 - 14 6	NA	NA	NA	--	--	--	ND	--	--	--
SEP3089BR1214	12 6 - 13.6	990 AJB	450 AJB	ND	NA	NA	NA	NA	NA	NA	NA
SEP3089BR1521	14 6 - 20 6	NA	NA	NA	10,700	--	203	--	--	27	18
SEP3089BR1618	16 6 - 18 6	ND	540 AJB	ND	NA	NA	NA	NA	NA	NA	NA
SEP3089BR2022	20.6 - 22.6	2,700 AB	630 AJB	340 AJ	NA	NA	NA	NA	NA	NA	NA
SEP3089BR2127	20 6 - 26 6	NA	NA	NA	--	--	169	ND	7,920	12	24
SEP3089BR2426	24 6 - 26.6	1,700 AB	590 AJB	ND	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected
P = pH within background range

TABLE 2.22 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P210189

Sample Number	Sample Depth (ft)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Americium 241 (pCi/g)	Gross Alpha (pCi/g)
SEP3089BR0002	0.0 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0003	0 0 3 0	18,100	16	3 830	–	–	4 320	49	63	NA	490
SEP3089BR0309	3 0 9 0	16 000	–	3 010	–	–	4 620	–	–	0 2	–
SEP3089BR0406	4 6 6 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0810	8 6 9 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0915	9 0 14 6	–	–		–	–	–	–	–	0 1	
SEP3089BR1214	12.6 13 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR1521	14 6 20 6	21,200	–		533	22	–	31	83	–	–
SEP3089BR1618	16 6 18 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR2022	20 6 22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR2127	20 6 26 6	21,200			382	22	–	58	–	–	
SEP3089BR2426	24 6 26 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
– = Constituent present at concentration less than background
ND = Not detected
P = pH within background range

180/266

TABLE 2.22 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P210189

Sample Number	Sample Depth (ft)	Gross Beta (pCi/g)	Plutonium-239/240 (pCi/g)	Radium 226 (pCi/g)	Strontium -90 (pCi/g)	Tritium (pCi/ml)	Uranium 233, -234 (pCi/g)	Uranium-235 (pCi/g)	Uranium 238 (pCi/g)	Nitrate/ Nitrite (mg/kg)	pH (pH units)
SEP3089BR0002	00 - 23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0003	0.0 30	120	NA	1 0	ND	--	1 6	0 1	1 1	380 V	9 6
SEP3089BR0309	30 90	--	0 83	0 7	2.6	0.7	7 1	0 3	1 4	130 V	--P
SEP3089BR0406	4 6 - 6 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0810	8 6 9 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR0915	90 14 6	--	0 7	0 7	ND	0 7	0 7	ND	--		P
SEP3089BR1214	12 6 13 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR1521	14 6 20 6	--	0 08	--	ND	2.1	1 5	ND	1 4	11 V	--P
SEP3089BR1618	16 6 18 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEP3089BR2022	20 6 22.6	NA	NA	NA	NA	NA	NA	ND	NA	NA	NA
SEP3089BR2127	20 6 26 6	--	0 04	--	ND	2.1	1 2	NA	1 3	8 V	--P
SEP3089BR2426	24 6 26 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected
P = pH within background range

181/266

TABLE 2.23
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND
IN BOREHOLE SAMPLES FROM SP16-87 (WELL 5687)

Sample Number	Sample Depth (ft)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Calcium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Iron (mg/Kg)	Lead (mg/Kg)	Manganese (mg/Kg)	Potassium (mg/Kg)
SP168702FS	0 0 - 2 0	5	–	–	21	17	16363	–	–	4400
SP168708UC	6 0 - 8 0	14	3	–	–	–	–	–	–	–
SP168710CT	10 0 - 11 2	13	3	85844	18	–	–	21	–	–
SP168711BR	11 2 - 13 4	16	3	–	17	22	–	20	1258	–

Sample Number	Sample Depth (ft)	Zinc (mg/Kg)	Americium-241 (pCi/g)	Gross Alpha (pCi/g)	Plutonium-239/240 (pCi/g)	Uranium-233, -234 (pCi/g)	Uranium-238 (pCi/g)	Nitrate/Nitrite (mg/Kg)
SP168702FS	0 0 - 2 0	103	0 96	59	9	1 1	0 78	11
SP168708UC	6 0 - 8 0	–	ND	–	ND	–	–	12
SP168710CT	10 0 - 11 2	–	ND	–	ND	–	–	3
SP168711BR	11 2 - 13 4	–	ND	–	ND	–	–	–

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
– = Constituent present at concentration less than background
ND = Not detected

182/266

TABLE 2.24
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P219189

Sample Number	Sample Depth (ft)	1,1-Dichloro-ethane (ug/kg)	Methylene Chloride (ug/kg)	Aluminum (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)
P2191890002	00 10	ND	ND	NA	NA	NA	NA	NA	NA	NA
P2191890003	00 30	NA	NA	–	ND	102		15		14
P2191890204	2.0 40	ND	ND	NA	NA	NA	NA	NA	NA	NA
P2191890307	30 66	NA	NA	NA	NA	NA	NA	NA	NA	NA
P2191890307D	30 6 6(dup)	NA	NA	–	–	83	–	NA	NA	NA
P2191890406	40 58	ND	ND	NA	NA	NA	NA	NA	NA	NA
P2191890406D	4 0 - 5 8(dup)	ND	ND	NA	NA	NA	NA	NA	NA	NA
P2191890608	6.0 66	ND	ND	NA	NA	NA	NA	NA	NA	NA
P2191890711	70 110	NA	NA	–	6	84	–	12	14 400	20
P2191890810	80 89	4 AJ	ND	NA	NA	NA	NA	NA	NA	NA
P2191891012	100 110	ND	ND	NA	NA	NA	NA	NA	NA	NA
P2191891116	110 144	NA	NA	12,500	10	161	15	34	15 800	43
P2191891416	140 144	ND	4 JB	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
– = Constituent present at concentration less than background
ND = Not detected

183/266

TABLE 2.24 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P219189

Sample Number	Sample Depth (ft)	Magnesium (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Americium-241 (pCi/g)	Radium 226 (pCi/g)	Radium-228 (pCi/g)
P2191890002	0 0 - 1 0	NA	NA	NA	NA	NA	NA	NA	NA
P2191890003	0 0 - 3 0		–		–	93	0 07	1 1	2 9
P2191890204	2 0 - 4 0	NA	NA	NA	NA	NA	NA	NA	NA
P2191890307	3 0 - 6 6	NA	NA	NA	NA	NA	NA	NA	NA
P2191890307D	3 0 - 6 6(dup)	–	248		–	116	–	1 2	–
P2191890406	4 0 - 5 8	NA	NA	NA	NA	NA	NA	NA	NA
P2191890406D	4 0 5.8(dup)	NA	NA	NA	NA	NA	NA	NA	NA
P2191890608	6 0 - 6 6	NA	NA	NA	NA	NA	NA	NA	NA
P2191890711	7 0 - 11 0	3 780	–	–	–	105	–	1 3	2 1
P2191890810	8 0 8 9	NA	NA	NA	NA	NA	NA	NA	NA
P2191891012	10 0 - 11 0	NA	NA	NA	NA	NA	NA	NA	NA
P2191891116	11 0 - 14 4	4,100	–	27	28	174	–	1 7	2 2
P2191891416	14 0 - 14 4	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
– = Constituent present at concentration less than background
ND = Not detected

1E4/266

TABLE 2.24 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P219189

Sample Number	Sample Depth (ft)	Tritium (pCi/ml)	Uranium-233, -234 (pCi/g)	Uranium-238 (pCi/g)	Nitrate/Nitrate (mg/kg)
P2191890002	0.0 - 1 0	NA	NA	NA	NA
P2191890003	0 0 3 0	1790	0 8	0 9	NA
P2191890204	2.0 4 0	NA	NA	NA	NA
P2191890307	3 0 6 6	NA	NA	NA	NA
P2191890307	3.0 6 6(dup)	1840	1 0	1 0	ND
P2191890406	4 0 5 8	NA	NA	NA	NA
P2191890406D	4 0 5 8(dup)	NA	NA	NA	NA
P2191890608	6 0 6 6	NA	NA	NA	NA
P2191890711	7 0 - 11 0	1940	1 1	1 0	2.8 V
P2191890810	8 0 8 9	NA	NA	NA	NA
P2191891012	10 0 11 0	NA	NA	NA	NA
P2191891116	11 0 14 4	1230	1 8	1 6	3 4 V
P2191891416	14 0 14 4	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

185/266

TABLE 2.25
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P207389

Sample Number	Sample Depth (ft)	Acetone (g/kg)	Methylene Chloride (g/kg)	Aluminum (mg/kg)	Barium (mg/kg)	Calcium (mg/kg)	Lithium (mg/kg)	Magnesium (mg/kg)	Strontium (mg/kg)	Zinc (mg/kg)	Nitrate/ Nitrite (mg/kg)
SEP0189BR0002	0 0 - 2.0	9 AJB	10 V	NA	NA	NA	NA	NA	NA	NA	NA
SEP0189BR0003	0 0 3 0	NA	NA	22,800 J	91 4	–	776	–	–	46 6	5 3 V
SEP0189BR0307	3 0 7 0	NA	NA	–	–	75 600	ND	2,760	–	–	ND
SEP0189BR0406	4 3 - 5 3	42 AB	9 V	NA	NA	NA	NA	NA	NA	NA	NA
SEP0189BR0713	7 0 13.0	NA	NA	–	–	36,500	ND	–	189	–	ND
SEP0189BR0810	8 3 10 3	62 AB	10 V	NA	NA	NA	NA	NA	NA	NA	NA
SEP0189BR1214	12 3 - 13.8	66 AB	4 AJ	NA	NA	NA	NA	NA	NA	NA	NA
SEP0189BR1319	13 0 - 19 3	NA	NA	–	–	–	ND	–	–	–	ND
SEP0189BR1618	16 3 - 18 3	34 AB	3 AJ	NA	NA	NA	NA	NA	NA	NA	NA
SEP0189BR1920	19 3 20 3	29 AB	3 AJ	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid A = Validated and valid with qualifiers J = Detected at concentration less than detection limit ND = Not detected
NA = Not analyzed B = Constituent detected in laboratory blank – = Constituent present at concentration less than background

186/266

TABLE 2.26
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL P207389

Sample Number	Sample Date	Acetone (g/l)	Chloroform (g/l)	Methylene Chloride (g/l)	Calcium (mg/l)	Mercury (mg/l)	Bicarbonate (mg/l)
GSEP01890989001	21-SEP 89	ND	ND	ND	70	ND	380
GSEP1890390007	14 MAR 90	ND	ND	ND	NA	NA	400
SEP0189-0604-02-0940	05 JUN 90	17	ND	6	78	0 0003	329
GW00244IT	21-AUG-90	ND	ND	3 JB	76	ND	320
GW00799IT	18 DEC-90	5 AJB	2 AJ	1 ND	91	ND	410
GW01028IT	26-MAR-91	9 AJ	ND	ND	85	0 0006	310
GW01361IT	31-MAY-91	ND	ND	6	91	ND	320
GW01616IT	07 AUG-91	ND	ND	ND	86	ND	340
GW01895IT	24-OCT-91	ND	ND	ND	89	ND	310
GW02258IT	04-MAR-92	NA	NA	NA	NA	NA	330

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

187/766

TABLE 2.27
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL P207489

Sample Number	Sample Depth (ft)	Acetone (g/kg)	Methylene Chloride (g/kg)	Aluminum (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)
SEP2890002	00 - 20	ND	3 AJ	NA	NA	NA	NA	NA
SEP2890003	00 - 30	NA	NA	--	--	--	13,700	--
SEP2890306	30 - 65	NA	NA	30,400	120	8 7	--	81 2
SEP2890406	40 - 50	38 AB	4 AJ	NA	NA	NA	NA	NA
SEP2890610	65 - 100	NA	NA	--	--	--	--	
SEP2890810	80 - 100	40 AB	ND	NA	NA	NA	NA	NA

Sample Number	Sample Depth (ft)	Copper (mg/kg)	Iron (mg/kg)	Magnesium (mg/kg)	Potassium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Nitrate/Nitrite (mg/kg)
SEP2890002	00 - 20	NA	NA	NA	NA	NA	NA	NA
SEP2890003	00 - 30	--	--	--	--	--	--	8 3 V
SEP2890306	30 - 65	26 6	33,500	3,120	2,540	64 3	62 1	
SEP2890406	40 - 50	NA	NA	NA	NA	NA	NA	NA
SEP2890610	6.5 - 100	--	--	-	ND	ND	--	ND
SEP2890810	80 - 100	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

188/266

189/266

TABLE 2.28
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL P207489

Sample Number	Sample Date	Acetone (g/l)	Carbon Tetrachloride (g/l)	1,1-Dichloroethene (g/l)	Methylene Chloride (g/l)	Calcium (mg/l)
GSEP02890989001	20-SEP-89	ND	1 J	2 J	ND	90
GSEP02890390001	14 MAR-90	8 J	ND	ND	4 JB	88
SEP0289-0531-02-1430	01 JUN 90	18 B	ND	ND	15 B	88
GW0023IT	14 AUG 90	ND	ND	ND	ND	NA
GW00800IT	18 DEC 90	ND	ND	ND	ND	NA
GW01195IT	01 MAY 91	ND	ND	ND	ND	NA
GW01362IT	31 MAY 91	ND	ND	ND	1 JB	96
GW01618IT	07 AUG 91	ND	ND	ND	ND	NA
GW01896IT	24 OCT-91	ND	ND	ND	ND	NA
GW02259IT	04 MAR 92	NA	NA	NA	NA	NA

Sample Number	Sample Date	Magnesium (mg/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Nitrate/Nitrite (mg/l)	Sulfate (mg/l)
GSEP02890989001	20-SEP 89	23	360	25	--	78
GSEP02890390001	14 MAR 90	23	360	30	--	84
SEP0289-0531-02-1430	01 JUN 90	24	313	NA	--	NA
GW0023IT	14 AUG-90	NA	300	22	9 4	130
GW00800IT	18 DEC 90	NA	NA	NA	--	NA
GW01195IT	01 MAY 91	NA	300	26	4 3	72
GW01362IT	31 MAY 91	26	310	230	4 3	70
GW01618IT	07 AUG 91	NA	300	22	9 4	130
GW01896IT	24 OCT 91	NA	280	29	3 7	77
GW02259IT	04 MAR 92	NA	290	34	4 0	75

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

TABLE 2.29
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN BOREHOLE SAMPLES FROM WELL SP03-87

Sample Number	Sample Depth (ft)	Chloroform (g/kg)	Bis(2 Ethylhexyl) phthalate (g/kg)	Di-n Butyl Phthalate (g/kg)	Methylene Chloride (g/kg)	N-Nitro-sodiphenyl amine (g/kg)	Trichloro-ethene (g/kg)	Aluminum (mg/kg)	Arsenic (mg/kg)	Calcium (mg/kg)
SP028702DH	2.0 - 3.5	ND	830	44 J	13 JB	83 J	9 JB	--	--	--
SP028703FS	4.0 4.6	ND	NA	NA	18 JB	NA	8 JB	NA	NA	NA
SP028711DH	10.3 11.6	ND	NA	NA	ND	NA	ND	--	--	--
SP028713CT	12.8 14.4	ND	NA	NA	18 J	NA	ND	--	--	
SP028716BR	15.2 16.9	5 J	NA	NA	ND	NA	ND	10704	11	10348

Sample Number	Sample Depth (ft)	Chromium (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Vanadium (mg/kg)	Tritium (pCi/ml)	Uranium 233,234 (pCi/g)	Uranium-238 (pCi/g)	Nitrate/ Nitrate mg/kg	pH (pH units)
SP028702DH	2.0 - 3.5	--	--	--	--	ND	1.3	1.1	NA	NA
SP028703FS	4.0 4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
SP028711DH	10.3 11.6	--	--	ND	--	ND	--	--	200	4.76
SP028713CT	12.8 14.4	13	19	ND	--	1.1	--	--	186	P
SP028716BR	15.2 16.9	--	--	23	30	2	--	--	260	P

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected
P = pH within background range

190/266

TABLE 2.30
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2187

Sample Number	Sample Date	Acetone (g/l)	Carbon Disulfide (g/l)	Methylene Chloride (g/l)	Perchloroethene (g/l)	Calcium (mg/l)	Copper (mg/l)	Magnesium (mg/l)	Nickel (mg/l)
21 87-03-07 88	07 MAR 88	ND	ND	ND	6	NA	NA	NA	NA
21 87 05-02 88	02 MAY-88	ND	ND	ND	49	NA	NA	NA	NA
21 87 11-08 88	08 NOV-88	ND	ND	ND	4 J	NA	NA	NA	NA
G21871189004	10-NOV-89	ND	ND	ND	ND	NA	NA	NA	NA
21 87-08 15 89	15 AUG-89	ND	ND	ND	2 J	NA	NA	NA	NA
G21870290001	06-FEB-90	ND	ND	ND	ND	NA	NA	NA	NA
G 2187 0517 02 1116	18 MAY-90	68	1 J	3 J	ND	288	0 78	101	1 2
GW00755IT	12 DEC 90	ND	ND	ND	ND	NA	NA	NA	NA
GW01187IT	24-APR-91	ND	ND	ND	ND	NA	NA	NA	NA
GW01400IT	11 JUN-91	ND	ND	1 JB	ND	NA	NA	NA	NA
GW01613IT	06-AUG-91	ND	ND	ND	ND	NA	NA	NA	NA
GW01929IT	17-OCT-91	ND	ND	ND	ND	NA	NA	NA	NA
GW02520IT	27 FEB-92	NA	NA	NA	NA	NA	NA	NA	NA

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

191/266

192/266

TABLE 2 30 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2187

Sample Number	Sample Date	Sodium (mg/l)	Zinc (mg/l)	Uranium 233, 234 (pCi/l)	Uranium 235 (pCi/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Sulfate (mg/l)
21 87-03-07-88	07-MAR 88	NA	NA	NA	NA	NA	NA	NA
21 87-05-02 88	02 MAY 88	NA	NA	NA	NA	NA	NA	NA
21 87 11-08 88	08-NOV 88	NA	NA	NA	NA	NA	NA	NA
G21871189004	10-NOV 89	NA	NA	23 4	1 15	NA	NA	NA
21 87 08 15 89	15 AUG 89	NA	NA	NA	NA	NA	NA	NA
G21870290001	06-FEB 90	NA	NA	21.5	--	1100	--	--
G 2187 0517-02 1116	18 MAY 90	270	4 2	NA	NA	870	--	665
GW00108IT	05 SEP 90	NA	NA	NA	NA	920	--	640
GW00755IT	12 DEC 90	NA	NA	33 4	1 06	NA	NA	NA
GW01187IT	24-APR 91	NA	NA	27 3	0.63	850	--	650
GW01400IT	11-JUN 91	NA	NA	NA	NA	840	130	540
GW01613IT	06-AUG 91	NA	NA	NA	NA	840	120	810
GW01929IT	17-OCT 91	NA	NA	NA	NA	900	130	1100
GW02520IT	27 FEB 92	NA	NA	NA	NA	840	230	1200

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

TABLE 2.31
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2287

Sample Number	Sample Date	Acetone (g/l)	2-Butanone (g/l)	Methylene Chloride (g/l)	Perchloroethene (g/l)	Calcium (mg/l)
22-87-03-07-88	07-MAR-88	ND	9 J	ND	ND	--
22 87-05-02 88	02-MAY 88	ND	ND	ND	7	--
22 87-08-10-88	10-AUG-88	2 JB	ND	2 JB	ND	--
22 87-11-09 88	09-NOV-88	ND	ND	ND	ND	--
22 87-02 09 89	09-FEB 89	ND	ND	ND	ND	54
22 87-05-03 89	03-MAY-89	ND	ND	ND	ND	54
22-87-08-15 89	15-AUG 89	ND	ND	ND	ND	66
G22871189004	10-NOV-89	ND	ND	ND	ND	63
G22870290001	08-FEB-90	ND	ND	ND	ND	67
G-2287-0524 02-1410	25-MAY-90	ND	ND	ND	ND	67
GW00756IT	12 DEC-90	ND	ND	ND	ND	79
GW01198IT	24-APR 91	ND	ND	ND	ND	82
GW01402IT	11-JUN-91	ND	ND	1 JB	ND	65
GW01614IT	06 AUG-91	ND	ND	ND	ND	72
GW01927IT	24 OCT-91	ND	ND	ND	ND	68
GW02276IT	29-JAN 92	ND	ND	ND	ND	82

V = Validated and valid
NA = Not analyzed

A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank

J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background

ND = Not detected

193/266

TABLE 2.31 (continued)
SUMMARY OF CONSTITUENTS DETECTED IN CONCENTRATIONS ABOVE BACKGROUND IN GROUNDWATER SAMPLES FROM WELL 2287

Sample Number	Sample Date	Americium-241 (pCi/l)	Cesium-137 (pCi/l)	Strontium -89, -90 (pCi/l)	Uranium-235 (pCi/l)	Sulfate (mg/l)
22-87-03-07-88	07-MAR-88	ND	NA	NA	0.18	--
22-87-05-02-88	02-MAY-88	ND	NA	NA	0 14	230
22-87-08-10-88	10-AUG-88	ND	NA	NA	ND	337
22-87-11-09-88	09-NOV-88	ND	NA	NA	ND	387
22-87-02 09-89	09 FEB 89	0 11	NA	NA	ND	458
22-87-05-03 89	03-MAY-89	NA	NA	NA	NA	460
22-87-08 15-89	15-AUG-89	NA	NA	NA	ND	478
G22871189004	10-NOV-89	ND	1 6	ND	0 11	480
G22870290001	08 FEB-90	--	NA	ND	ND	370
G-2287-0524-02-1410	25-MAY-90	--	ND	--	ND	480
GW00756IT	12-DEC-90	NA	ND	--	ND	480
GW01198IT	24-APR-91	ND	ND	5.5	ND	500
GW01402IT	11 JUN-91	ND	ND	--	ND	350
GW01614IT	06-AUG-91	ND	ND	--	ND	570
GW01927IT	24-OCT-91	NA	NA	NA	NA	530
GW02276IT	29 JAN-92	NA	NA	NA	NA	840

V = Validated and valid
NA = Not analyzed
A = Validated and valid with qualifiers
B = Constituent detected in laboratory blank
J = Detected at concentration less than detection limit
-- = Constituent present at concentration less than background
ND = Not detected

194/266

TABLE 2.32

RFEDS DATA FOR SURFACE-WATER AND SEDIMENT SAMPLING SITES

SURFACE-WATER SAMPLING SITE	CONTAMINANT TYPE[2]	SEDIMENT SAMPLING SITE	CONTAMINANT TYPE[2]
SW018	A,B,C,D	SED009	A,B,C,D
SW043	A,B,C,D	SED010	A,B,C,D
SW056	A,B,D	SED011	A,D
SW059	A,D	SED012	A,D
SW060	A,D	SED118	A,B,C,D
SW061	A,D	SED120	A,B,C,D
SW084	A	SED124	A
SW085	A,B,C		
SW086	A,B		
SW093	A,B,C,D		
SW101	A,D		
SW102	A,B,C,D		
SW118	A,B,C,D		
SW119 (no data)[1]	A,B,C,D		
SW120 (no data)[1]	A,B,C,D		
SW122	A,D		
SW124	A		
SW132	A,D		
SW371 (no data)[1]	A,B,C		

1) RFEDS datafile contains no information, per EG&G, no information is currently available for these sampling sites.
2) Contaminant type based on historical release information (see Sections 2.3 and 2.4)

A - Radionuclides B - Trace Metals C - Inorganics D - Volatile Organics

196/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW018	30-May-91	METHYLENE CHLORIDE	B	6	UG/L
SW018	17-Jun-91	METHYLENE CHLORIDE	B	36	UG/L
SW018	09-Sep-91	METHYLENE CHLORIDE	B	9	UG/L
SW056	13-Apr-89	ACETONE		130	UG/L
SW056	13-Apr-89	METHYLENE CHLORIDE		29	UG/L
SW056	13-Apr-89	TETRACHLOROETHENE		190	UG/L
SW056	13-Apr-89	TRICHLOROETHENE		120	UG/L
SW056	11-May-89	1,1-DICHLOROETHANE		5	UG/L
SW056	11-May-89	1,1,1-TRICHLOROETHANE		9	UG/L
SW056	11-May-89	TETRACHLOROETHENE		200	UG/L
SW056	11-May-89	TRICHLOROETHENE		140	UG/L
SW056	07-Jun-89	1,1,1-TRICHLOROETHANE		9	UG/L
SW056	07-Jun-89	TETRACHLOROETHENE		190	UG/L
SW056	07-Jun-89	TRICHLOROETHENE		130	UG/L
SW056	07-Jun-89	VINYL CHLORIDE		15	UG/L
SW056	12-Jul-89	TETRACHLOROETHENE		280	UG/L
SW056	12-Jul-89	TRICHLOROETHENE		140	UG/L
SW056	12-Jul-89	METHYLENE CHLORIDE	B	36	UG/L
SW056	15-Nov-89	1,2-DICHLOROETHENE		120	UG/L
SW056	15-Nov-89	TETRACHLOROETHENE		110	UG/L
SW056	15-Nov-89	TRICHLOROETHENE		69	UG/L
SW056	15-Nov-89	ACETONE	B	10	UG/L
SW056	15-Nov-89	METHYLENE CHLORIDE	B	6	UG/L
SW056	19-Dec-89	1,1-DICHLOROETHANE		50	UG/L
SW056	19-Dec-89	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	19-Dec-89	METHYLENE CHLORIDE		6	UG/L
SW056	19-Dec-89	TETRACHLOROETHENE		86	UG/L
SW056	19-Dec-89	TRICHLOROETHENE		69	UG/L
SW056	19-Dec-89	VINYL CHLORIDE		10	UG/L
SW056	25-Jan-90	1,2-DICHLOROETHENE		130	UG/L
SW056	25-Jan-90	TETRACHLOROETHENE		74	UG/L
SW056	25-Jan-90	TRICHLOROETHENE		50	UG/L
SW056	22-Feb-90	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	22-Feb-90	1,2-DICHLOROETHENE		230	UG/L
SW056	22-Feb-90	TETRACHLOROETHENE		120	UG/L
SW056	22-Feb-90	TRICHLOROETHENE		92	UG/L
SW056	22-Feb-90	VINYL CHLORIDE		11	UG/L
SW056	22-Feb-90	METHYLENE CHLORIDE	B	5	UG/L

197/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW056	18-Apr-90	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	18-Apr-90	1,2-DICHLOROETHENE		180	UG/L
SW056	18-Apr-90	TETRACHLOROETHENE		120	UG/L
SW056	18-Apr-90	TRICHLOROETHENE		67	UG/L
SW056	18-Apr-90	METHYLENE CHLORIDE	B	5	UG/L
SW056	08-May-90	1,2-DICHLOROETHENE		240	UG/L
SW056	08-May-90	TETRACHLOROETHENE		140	UG/L
SW056	08-May-90	TRICHLOROETHENE		75	UG/L
SW056	28-Jun-90	1,1-DICHLOROETHANE		5	UG/L
SW056	28-Jun-90	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	28-Jun-90	TETRACHLOROETHENE		190	UG/L
SW056	28-Jun-90	TRICHLOROETHENE		120	UG/L
SW056	28-Jun-90	VINYL CHLORIDE		13	UG/L
SW056	18-Jul-90	1,1-DICHLOROETHANE		5	UG/L
SW056	18-Jul-90	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	18-Jul-90	TRICHLOROETHENE		100	UG/L
SW056	18-Jul-90	VINYL CHLORIDE		13	UG/L
SW056	11-Sep-90	1,1-DICHLOROETHANE		6	UG/L
SW056	11-Sep-90	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	11-Sep-90	TRICHLOROETHENE		120	UG/L
SW056	11-Sep-90	VINYL CHLORIDE		16	UG/L
SW056	17-Dec-90	1,2-DICHLOROETHENE		260	UG/L
SW056	17-Dec-90	TETRACHLOROETHENE		82	UG/L
SW056	17-Dec-90	TRICHLOROETHENE		65	UG/L
SW056	17-Dec-90	METHYLENE CHLORIDE	B	11	UG/L
SW056	26-Mar-91	1,2-DICHLOROETHANE		23	UG/L
SW056	26-Mar-91	1,2-DICHLOROETHENE		240	UG/L
SW056	26-Mar-91	TETRACHLOROETHENE		93	UG/L
SW056	26-Mar-91	TRICHLOROETHENE		100	UG/L
SW056	26-Mar-91	VINYL CHLORIDE		15	UG/L
SW056	24-Apr-91	1,1,1-TRICHLOROETHANE		5	UG/L
SW056	24-Apr-91	1,2-DICHLOROETHENE		310	UG/L
SW056	24-Apr-91	TETRACHLOROETHENE		97	UG/L
SW056	24-Apr-91	TRICHLOROETHENE		92	UG/L
SW056	24-Apr-91	VINYL CHLORIDE		25	UG/L
SW056	29-May-91	1,2-DICHLOROETHENE		210	UG/L
SW056	29-May-91	TETRACHLOROETHENE		95	UG/L
SW056	29-May-91	TRICHLOROETHENE		73	UG/L
SW056	29-May-91	VINYL CHLORIDE		13	UG/L
SW056	29-May-91	METHYLENE CHLORIDE	B	7	UG/L

198/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW056	17-Jun-91	1,2-DICHLOROETHENE		270	UG/L
SW056	17-Jun-91	TETRACHLOROETHENE		120	UG/L
SW056	17-Jun-91	TRICHLOROETHENE		73	UG/L
SW056	17-Jun-91	VINYL CHLORIDE		14	UG/L
SW056	17-Jun-91	METHYLENE CHLORIDE	B	6	UG/L
SW056	19-Aug-91	1,2-DICHLOROETHENE		280	UG/L
SW056	19-Aug-91	TETRACHLOROETHENE		110	UG/L
SW056	19-Aug-91	TRICHLOROETHENE		73	UG/L
SW056	07-Oct-91	TETRACHLOROETHENE		140	UG/L
SW056	07-Oct-91	TRICHLOROETHENE		98	UG/L
SW056	07-Oct-91	VINYL CHLORIDE		27	UG/L
SW056	05-Feb-92	TETRACHLOROETHENE		100	UG/L
SW056	05-Feb-92	TRICHLOROETHENE		110	UG/L
SW056	05-Feb-92	VINYL CHLORIDE		22	UG/L
SW059	21-Jul-87	1,1-DICHLOROETHENE		133	UG/L
SW059	21-Jul-87	CARBON TETRACHLORIDE		605	UG/L
SW059	21-Jul-87	CHLOROFORM		40	UG/L
SW059	21-Jul-87	TETRACHLOROETHENE		60	UG/L
SW059	21-Jul-87	TRICHLOROETHENE		62	UG/L
SW059	01-Jul-88	1,1,1-TRICHLOROETHANE		9 3	UG/L
SW059	01-Jul-88	CARBON TETRACHLORIDE		187	UG/L
SW059	01-Jul-88	CHLOROFORM		18 7	UG/L
SW059	01-Jul-88	TETRACHLOROETHENE		45	UG/L
SW059	01-Jul-88	TRICHLOROETHENE		49	UG/L
SW059	20-Mar-89	1,1,1-TRICHLOROETHANE		42	UG/L
SW059	20-Mar-89	CARBON TETRACHLORIDE		430	UG/L
SW059	20-Mar-89	CHLOROFORM		82	UG/L
SW059	20-Mar-89	TETRACHLOROETHENE		270	UG/L
SW059	20-Mar-89	TRICHLOROETHENE		260	UG/L
SW059	11-May-89	1,1,1-TRICHLOROETHANE		36	UG/L
SW059	11-May-89	CARBON TETRACHLORIDE		310	UG/L
SW059	11-May-89	CHLOROFORM		66	UG/L
SW059	11-May-89	TETRACHLOROETHENE		170	UG/L
SW059	11-May-89	TRICHLOROETHENE		180	UG/L
SW059	08-Jun-89	1,1,1-TRICHLOROETHANE		15	UG/L
SW059	08-Jun-89	CARBON TETRACHLORIDE		200	UG/L
SW059	08-Jun-89	CHLOROFORM		20	UG/L
SW059	08-Jun-89	TETRACHLOROETHENE		57	UG/L
SW059	08-Jun-89	TRICHLOROETHENE		60	UG/L

199/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW059	06-Jul-89	1,1,1-TRICHLOROETHANE		10	UG/L
SW059	06-Jul-89	1,2-DICHLOROETHENE		56	UG/L
SW059	06-Jul-89	CARBON TETRACHLORIDE		190	UG/L
SW059	06-Jul-89	CHLOROFORM		26	UG/L
SW059	06-Jul-89	TETRACHLOROETHENE		56	UG/L
SW059	06-Jul-89	TRICHLOROETHENE		55	UG/L
SW059	06-Jul-89	ACETONE	B	13	UG/L
SW059	06-Jul-89	METHYLENE CHLORIDE	B	9	UG/L
SW059	18-Sep-89	1,1,1-TRICHLOROETHANE		9	UG/L
SW059	18-Sep-89	CARBON TETRACHLORIDE		190	UG/L
SW059	18-Sep-89	CHLOROFORM		23	UG/L
SW059	18-Sep-89	TETRACHLOROETHENE		53	UG/L
SW059	18-Sep-89	TRICHLOROETHENE		63	UG/L
SW059	03-Oct-89	CARBON TETRACHLORIDE		160	UG/L
SW059	03-Oct-89	CHLOROFORM		25	UG/L
SW059	03-Oct-89	TETRACHLOROETHENE		43	UG/L
SW059	03-Oct-89	TRICHLOROETHENE		52	UG/L
SW059	06-Nov-89	1,1,1-TRICHLOROETHANE		9	UG/L
SW059	06-Nov-89	1,2-DICHLOROETHENE		34	UG/L
SW059	06-Nov-89	CARBON TETRACHLORIDE		140	UG/L
SW059	06-Nov-89	CHLOROFORM		21	UG/L
SW059	06-Nov-89	ACETONE	B	38	UG/L
SW059	06-Dec-89	1,1,1-TRICHLOROETHANE		12	UG/L
SW059	06-Dec-89	CARBON TETRACHLORIDE		190	UG/L
SW059	06-Dec-89	CHLOROFORM		28	UG/L
SW059	06-Dec-89	TETRACHLOROETHENE		43	UG/L
SW059	06-Dec-89	TRICHLOROETHENE		57	UG/L
SW059	23-Jan-90	CARBON TETRACHLORIDE		130	UG/L
SW059	23-Jan-90	CHLOROFORM		15	UG/L
SW059	23-Jan-90	TETRACHLOROETHENE		26	UG/L
SW059	23-Jan-90	TRICHLOROETHENE		33	UG/L
SW059	09-Feb-90	1,2-DICHLOROETHENE		19	UG/L
SW059	09-Feb-90	CARBON TETRACHLORIDE		98	UG/L
SW059	09-Feb-90	TETRACHLOROETHENE		28	UG/L
SW059	09-Feb-90	CHLOROFORM	B	10	UG/L
SW059	09-Feb-90	TRICHLOROETHENE	B	16	UG/L
SW059	12-Mar-90	1,1,1-TRICHLOROETHANE		20	UG/L
SW059	12-Mar-90	1,2-DICHLOROETHENE		26	UG/L
SW059	12-Mar-90	CARBON TETRACHLORIDE		40	UG/L
SW059	12-Mar-90	CHLOROFORM		9	UG/L
SW059	12-Mar-90	TETRACHLOROETHENE		57	UG/L
SW059	12-Mar-90	TRICHLOROETHENE		54	UG/L
SW059	12-Mar-90	ACETONE	B	11	UG/L
SW059	12-Mar-90	METHYLENE CHLORIDE	B	8	UG/L

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW059	23-May-90	1,1,1-TRICHLOROETHANE		11	UG/L
SW059	23-May-90	1,2-DICHLOROETHENE		53	UG/L
SW059	23-May-90	CARBON TETRACHLORIDE		160	UG/L
SW059	23-May-90	CHLOROFORM		20	UG/L
SW059	23-May-90	TETRACHLOROETHENE		81	UG/L
SW059	23-May-90	TRICHLOROETHENE		71	UG/L
SW059	23-May-90	ACETONE	B	15	UG/L
SW059	23-May-90	METHYLENE CHLORIDE	B	9	UG/L
SW059	26-Jun-90	1,1,1-TRICHLOROETHANE		10	UG/L
SW059	26-Jun-90	1,2-DICHLOROETHENE		47	UG/L
SW059	26-Jun-90	CARBON TETRACHLORIDE		120	UG/L
SW059	26-Jun-90	CHLOROFORM		18	UG/L
SW059	26-Jun-90	TETRACHLOROETHENE		56	UG/L
SW059	26-Jun-90	TRICHLOROETHENE		62	UG/L
SW059	23-Jul-90	1,1,1-TRICHLOROETHANE		23	UG/L
SW059	23-Jul-90	1,2-DICHLOROETHENE		130	UG/L
SW059	23-Jul-90	CARBON TETRACHLORIDE		270	UG/L
SW059	23-Jul-90	CHLOROFORM		43	UG/L
SW059	23-Jul-90	TETRACHLOROETHENE		140	UG/L
SW059	23-Jul-90	TRICHLOROETHENE		200	UG/L
SW059	22-Aug-90	1,1-DICHLOROETHENE		10	UG/L
SW059	22-Aug-90	1,1,1-TRICHLOROETHANE		20	UG/L
SW059	22-Aug-90	1,2-DICHLOROETHENE		110	UG/L
SW059	22-Aug-90	CARBON TETRACHLORIDE		240	UG/L
SW059	22-Aug-90	CHLOROFORM		44	UG/L
SW059	22-Aug-90	TETRACHLOROETHENE		130	UG/L
SW059	22-Aug-90	TRICHLOROETHENE		170	UG/L
SW059	25-Sep-90	1,1-DICHLOROETHENE		10	UG/L
SW059	25-Sep-90	1,1,1-TRICHLOROETHANE		21	UG/L
SW059	25-Sep-90	1,2-DICHLOROETHENE		140	UG/L
SW059	25-Sep-90	CARBON TETRACHLORIDE		110	UG/L
SW059	25-Sep-90	CHLOROFORM		48	UG/L
SW059	25-Sep-90	TETRACHLOROETHENE		71	UG/L
SW059	25-Sep-90	TRICHLOROETHENE		180	UG/L
SW059	25-Sep-90	VINYL CHLORIDE		12	UG/L
SW059	16-Oct-90	1,1,1-TRICHLOROETHANE		11	UG/L
SW059	16-Oct-90	1,2-DICHLOROETHENE		94	UG/L
SW059	16-Oct-90	CARBON TETRACHLORIDE		140	UG/L
SW059	16-Oct-90	CHLOROFORM		33	UG/L
SW059	16-Oct-90	TETRACHLOROETHENE		87	UG/L
SW059	16-Oct-90	TRICHLOROETHENE		110	UG/L
SW059	26-Nov-90	1,1,1-TRICHLOROETHANE		12	UG/L
SW059	26-Nov-90	1,2-DICHLOROETHENE		150	UG/L
SW059	26-Nov-90	CARBON TETRACHLORIDE		150	UG/L
SW059	26-Nov-90	CHLOROFORM		30	UG/L
SW059	26-Nov-90	TETRACHLOROETHENE		88	UG/L
SW059	26-Nov-90	TRICHLOROETHENE		110	UG/L
SW059	26-Nov-90	VINYL CHLORIDE		16	UG/L

201/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW059	12-Dec-90	1,1-DICHLOROETHANE		5	UG/L
SW059	12-Dec-90	1,1-DICHLOROETHENE		7	UG/L
SW059	12-Dec-90	1,1,1-TRICHLOROETHANE		14	UG/L
SW059	12-Dec-90	1,2-DICHLOROETHENE		120	UG/L
SW059	12-Dec-90	CARBON TETRACHLORIDE		200	UG/L
SW059	12-Dec-90	CHLOROFORM		30	UG/L
SW059	12-Dec-90	TETRACHLOROETHENE		110	UG/L
SW059	12-Dec-90	TRICHLOROETHENE		140	UG/L
SW059	12-Dec-90	ACETONE	B	26	UG/L
SW059	09-Jan-91	1,1,1-TRICHLOROETHANE		31	UG/L
SW059	09-Jan-91	1,2-DICHLOROETHENE		50	UG/L
SW059	09-Jan-91	CHLOROFORM		28	UG/L
SW059	09-Jan-91	TETRACHLOROETHENE		170	UG/L
SW059	09-Jan-91	TRICHLOROETHENE		140	UG/L
SW059	27-Mar-91	1,1,1-TRICHLOROETHANE		6	UG/L
SW059	27-Mar-91	CARBON TETRACHLORIDE		62	UG/L
SW059	27-Mar-91	CHLOROFORM		10	UG/L
SW059	27-Mar-91	TETRACHLOROETHENE		28	UG/L
SW059	27-Mar-91	TRICHLOROETHENE		31	UG/L
SW059	11-Apr-91	1,1,1-TRICHLOROETHANE		5	UG/L
SW059	11-Apr-91	1,2-DICHLOROETHENE		25	UG/L
SW059	11-Apr-91	CARBON TETRACHLORIDE		81	UG/L
SW059	11-Apr-91	CHLOROFORM		11	UG/L
SW059	11-Apr-91	TETRACHLOROETHENE		34	UG/L
SW059	11-Apr-91	TRICHLOROETHENE		35	UG/L
SW059	08-May-91	1,1,1-TRICHLOROETHANE		15	UG/L
SW059	08-May-91	CARBON TETRACHLORIDE		68	UG/L
SW059	08-May-91	CHLOROFORM		8	UG/L
SW059	08-May-91	TETRACHLOROETHENE		55	UG/L
SW059	08-May-91	TRICHLOROETHENE		39	UG/L
SW059	20-Jun-91	1,1-DICHLOROETHENE		5	UG/L
SW059	20-Jun-91	1,1,1-TRICHLOROETHANE		13	UG/L
SW059	20-Jun-91	1,2-DICHLOROETHENE		70	UG/L
SW059	20-Jun-91	CARBON TETRACHLORIDE		140	UG/L
SW059	20-Jun-91	CHLOROFORM		23	UG/L
SW059	20-Jun-91	TETRACHLOROETHENE		76	UG/L
SW059	20-Jun-91	TRICHLOROETHENE		69	UG/L
SW059	07-Aug-91	1,1,1-TRICHLOROETHANE		7	UG/L
SW059	07-Aug-91	1,2-DICHLOROETHENE		27	UG/L
SW059	07-Aug-91	CARBON TETRACHLORIDE		47	UG/L
SW059	07-Aug-91	CHLOROFORM		6	UG/L
SW059	07-Aug-91	TETRACHLOROETHENE		36	UG/L
SW059	07-Aug-91	TRICHLOROETHENE		25	UG/L
SW059	07-Aug-91	METHYLENE CHLORIDE	B	10	UG/L

202/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1)]	Result	Unit
SW059	17-Sep-91	1,1,1-TRICHLOROETHANE		11	UG/L
SW059	17-Sep-91	1,2-DICHLOROETHENE		69	UG/L
SW059	17-Sep-91	CARBON TETRACHLORIDE		130	UG/L
SW059	17-Sep-91	CHLOROFORM		21	UG/L
SW059	17-Sep-91	TETRACHLOROETHENE		69	UG/L
SW059	17-Sep-91	TRICHLOROETHENE		79	UG/L
SW059	17-Sep-91	METHYLENE CHLORIDE	B	7	UG/L
SW059	27-Jan-92	1,1-DICHLOROETHANE		5	UG/L
SW059	27-Jan-92	1,1-DICHLOROETHENE		7	UG/L
SW059	27-Jan-92	1,1,1-TRICHLOROETHANE		17	UG/L
SW059	27-Jan-92	1,2-DICHLOROETHENE		110	UG/L
SW059	27-Jan-92	CARBON TETRACHLORIDE		190	UG/L
SW059	27-Jan-92	CHLOROFORM		34	UG/L
SW059	27-Jan-92	TETRACHLOROETHENE		99	UG/L
SW059	27-Jan-92	TRICHLOROETHENE		110	UG/L
SW059	27-Jan-92	ACETONE	B	10	UG/L
SW060	21-Jul-87	CARBON TETRACHLORIDE		173	UG/L
SW060	11-Nov-87	CARBON TETRACHLORIDE		145	UG/L
SW060	11-Nov-87	CHLOROFORM		10	UG/L
SW060	11-Nov-87	METHYLENE CHLORIDE		44	UG/L
SW060	11-Nov-87	TOLUENE		11	UG/L
SW060	11-Nov-87	TRICHLOROETHENE		25	UG/L
SW060	01-Jul-88	CARBON TETRACHLORIDE		46 5	UG/L
SW060	01-Jul-88	TETRACHLOROETHENE		10 3	UG/L
SW060	01-Jul-88	TRICHLOROETHENE		12.3	UG/L
SW060	16-Mar-89	CARBON TETRACHLORIDE		88	UG/L
SW060	16-Mar-89	CHLOROFORM		14	UG/L
SW060	16-Mar-89	TETRACHLOROETHENE		14	UG/L
SW060	16-Mar-89	TRICHLOROETHENE		15	UG/L
SW060	15-May-89	1,1,1-TRICHLOROETHANE		12	UG/L
SW060	15-May-89	CARBON TETRACHLORIDE		92	UG/L
SW060	15-May-89	CHLOROFORM		9	UG/L
SW060	15-May-89	TETRACHLOROETHENE		35	UG/L
SW060	15-May-89	TRICHLOROETHENE		31	UG/L
SW060	09-Jun-89	CARBON TETRACHLORIDE		74	UG/L
SW060	09-Jun-89	CHLOROFORM		5	UG/L
SW060	09-Jun-89	TETRACHLOROETHENE		18	UG/L
SW060	09-Jun-89	TRICHLOROETHENE		13	UG/L
SW060	06-Jul-89	CARBON TETRACHLORIDE		18	UG/L
SW060	06-Jul-89	METHYLENE CHLORIDE		11	UG/L
SW060	03-Oct-89	CARBON TETRACHLORIDE		21	UG/L
SW060	06-Nov-89	CARBON TETRACHLORIDE		23	UG/L

203/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW060	06-Dec-89	CARBON TETRACHLORIDE		4	UG/L
SW060	06-Dec-89	CHLOROBENZENE		7	UG/L
SW060	12-Mar-90	1,1,1-TRICHLOROETHANE		28	UG/L
SW060	12-Mar-90	CARBON TETRACHLORIDE		16	UG/L
SW060	12-Mar-90	TETRACHLOROETHENE		77	UG/L
SW060	12-Mar-90	TRICHLOROETHENE		66	UG/L
SW060	12-Mar-90	METHYLENE CHLORIDE	B	8	UG/L
SW060	23-May-90	CARBON TETRACHLORIDE		23	UG/L
SW060	23-May-90	TETRACHLOROETHENE		9	UG/L
SW060	23-May-90	TRICHLOROETHENE		9	UG/L
SW060	23-Jul-90	CARBON TETRACHLORIDE		20	UG/L
SW060	23-Jul-90	TETRACHLOROETHENE		7	UG/L
SW060	23-Jul-90	TRICHLOROETHENE		7	UG/L
SW060	22-Aug-90	CARBON TETRACHLORIDE		9	UG/L
SW060	26-Sep-90	CARBON TETRACHLORIDE		10	UG/L
SW060	16-Oct-90	CARBON TETRACHLORIDE		6	UG/L
SW060	16-Oct-90	METHYLENE CHLORIDE	B	5	UG/L
SW060	26-Nov-90	CARBON TETRACHLORIDE		9	UG/L
SW060	07-Dec-90	CARBON TETRACHLORIDE		10	UG/L
SW060	22-Mar-91	CARBON TETRACHLORIDE		10	UG/L
SW060	11-Apr-91	1,1,1-TRICHLOROETHANE		8	UG/L
SW060	11-Apr-91	TETRACHLOROETHENE		20	UG/L
SW060	11-Apr-91	TRICHLOROETHENE		14	UG/L
SW060	08-May-91	CARBON TETRACHLORIDE		35	UG/L
SW060	08-May-91	TETRACHLOROETHENE		17	UG/L
SW060	08-May-91	TRICHLOROETHENE		16	UG/L
SW060	20-Jun-91	CARBON TETRACHLORIDE		28	UG/L
SW060	20-Jun-91	TETRACHLOROETHENE		7	UG/L
SW060	20-Jun-91	TRICHLOROETHENE		8	UG/L
SW060	07-Aug-91	CARBON TETRACHLORIDE		19	UG/L
SW060	07-Aug-91	TETRACHLOROETHENE		13	UG/L
SW060	07-Aug-91	TRICHLOROETHENE		12	UG/L
SW060	17-Sep-91	CARBON TETRACHLORIDE		7	UG/L
SW060	17-Sep-91	METHYLENE CHLORIDE	B	19	UG/L
SW060	17-Oct-91	ACETONE	B	49	UG/L
SW060	17-Oct-91	METHYLENE CHLORIDE	B	11	UG/L
SW060	27-Jan-92	CARBON TETRACHLORIDE		11	UG/L
SW060	27-Jan-92	ACETONE	B	15	UG/L

204/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW093	29-Jan-90	METHYLENE CHLORIDE	B	7	UG/L
SW093	30-Jul-90	METHYLENE CHLORIDE	B	9	UG/L
SW093	15-Apr-91	METHYLENE CHLORIDE		19	UG/L
SW093	14-Aug-91	METHYLENE CHLORIDE	B	38	UG/L
SW093	19-Sep-91	TETRACHLOROETHENE		6	UG/L
SW093	19-Sep-91	METHYLENE CHLORIDE	B	6	UG/L

205/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW101	30-Jun-88	CHLOROFORM		79	UG/L
SW101	11-May-89	CHLOROFORM		53	UG/L
SW101	11-May-89	TETRACHLOROETHENE		14	UG/L
SW101	11-May-89	TRICHLOROETHENE		5	UG/L
SW101	07-Jun-89	CHLOROFORM		66	UG/L
SW101	12-Jul-89	CHLOROFORM		67	UG/L
SW101	09-Aug-89	ACETONE		65	UG/L
SW101	09-Aug-89	CHLOROFORM		57	UG/L
SW101	14-Sep-89	CHLOROFORM		38	UG/L
SW101	15-Nov-89	CHLOROFORM		30	UG/L
SW101	19-Dec-89	CHLOROFORM		24	UG/L
SW101	25-Jan-90	CHLOROFORM		39	UG/L
SW101	22-Feb-90	CHLOROFORM		27	UG/L
SW101	18-Apr-90	CHLOROFORM		6	UG/L
SW101	08-May-90	CHLOROFORM		6	UG/L
SW101	28-Jun-90	CHLOROFORM		8	UG/L
SW101	11-Sep-90	CHLOROFORM		20	UG/L
SW101	17-Dec-90	CHLOROFORM		29	UG/L
SW101	26-Mar-91	CHLOROFORM		17	UG/L
SW101	25-Apr-91	CHLOROFORM		19	UG/L
SW101	30-May-91	CHLOROFORM		18	UG/L
SW101	18-Jun-91	CHLOROFORM		22	UG/L
SW101	16-Jul-91	CHLOROFORM		41	UG/L
SW101	08-Oct-91	CHLOROFORM		22	UG/L
SW102	20-Mar-90	METHYLENE CHLORIDE	B	5	UG/L
SW102	17-Jul-90	1,1-DICHLOROETHENE		5	UG/L
SW102	17-Jul-90	CARBON TETRACHLORIDE		20	UG/L
SW102	17-Jul-90	CHLOROFORM		11	UG/L
SW102	17-Jul-90	TRICHLOROETHENE		20	UG/L

206/744

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SW118	29-Oct-90	METHYLENE CHLORIDE	B	6	UG/L
SW118	07-Aug-91	ACETONE	B	15	UG/L
SW118	07-Aug-91	METHYLENE CHLORIDE	B	12	UG/L
SW122	29-May-91	ACETONE	B	94	UG/L
SW122	29-May-91	METHYLENE CHLORIDE	B	33	UG/L
SW122	10-Sep-91	METHYLENE CHLORIDE	B	12	UG/L
SW122	07-Oct-91	METHYLENE CHLORIDE	B	6	UG/L
SED009	12-Aug-86	N-NITROSODIPHENYLAMINE	B	2000	UG/KG
SED009	08-May-91	BENZO(a)ANTHRACENE		590	UG/KG
SED009	08-May-91	CHRYSENE		610	UG/KG
SED009	08-May-91	FLUORANTHENE		1600	UG/KG
SED009	08-May-91	METHYLENE CHLORIDE	B	39	UG/KG
SED009	08-May-91	PHENANTHRENE		1700	UG/KG
SED009	08-May-91	PYRENE		1300	UG/KG
SED009	27-Aug-91	ACETONE	B	140	UG/KG
SED009	27-Aug-91	BIS(2-ETHYLHEXYL)PHTHALATE		650	UG/KG
SED009	27-Aug-91	METHYLENE CHLORIDE	B	23	UG/KG
SED009	27-Aug-91	PYRENE		480	UG/KG
SED009	03-Dec-91	ACETONE	B	16	UG/KG
SED009	26-Feb-92	ACETONE		16	UG/KG
SED009	26-Feb-92	METHYLENE CHLORIDE	B	37	UG/KG
SED010	22-Aug-86	ACETONE	B	55	UG/KG
SED010	22-Aug-86	N-NITROSODIPHENYLAMINE	B	440	UG/KG
SED011	13-Aug-86	2-BUTANONE		12	UG/KG
SED011	13-Aug-86	ACETONE		167	UG/KG
SED011	13-Mar-89	CARBON TETRACHLORIDE		52	UG/KG
SED011	13-Mar-89	CHLOROFORM		10	UG/KG
SED011	13-Mar-89	TETRACHLOROETHENE		39	UG/KG
SED011	13-Mar-89	TRICHLOROETHENE		17	UG/G
SED011	26-Oct-89	ACETONE	B	33	UG/KG
SED011	26-Oct-89	METHYLENE CHLORIDE	B	15	UG/KG
SED011	01-Jun-90	ACETONE		190	UG/KG
SED011	01-Jun-90	TETRACHLOROETHENE		17	UG/KG

207/266

Table 2.33
SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN OU8 SURFACE-WATER AND SEDIMENT SITES

Location	Sample Date	Chemical	Qual [1]	Result	Unit
SED011	14-May-91	ACETONE		24	UG/KG
SED011	14-May-91	METHYLENE CHLORIDE	B	40	UG/KG
SED011	03-Sep-91	ACETONE	B	49	UG/KG
SED011	03-Sep-91	METHYLENE CHLORIDE	B	94	UG/KG
SED011	03-Dec-91	ACETONE	B	28	UG/KG
SED011	03-Dec-91	METHYLENE CHLORIDE	B	15	UG/KG
SED012	13-Aug-86	ACETONE		39	UG/KG
SED012	13-Aug-86	ACETONE	B	21	UG/KG
SED012	13-Aug-86	TOLUENE		5	UG/KG
SED118	28-Nov-90	2-BUTANONE	B	59	UG/KG
SED118	21-May-91	METHYLENE CHLORIDE	B	110	UG/KG
SED118	13-Aug-91	ACETONE	B	21	UG/KG
SED118	13-Aug-91	METHYLENE CHLORIDE	B	23	UG/KG
SED120	19-Sep-90	METHYLENE CHLORIDE	B	8	UG/KG
SED120	26-Mar-91	METHYLENE CHLORIDE	B	5	UG/KG
SED120	29-May-91	ACETONE	B	24	UG/KG
SED120	29-May-91	METHYLENE CHLORIDE	B	15	UG/KG
SED120	20-Aug-91	ACETONE	B	12	UG/KG
SED120	20-Aug-91	FLUORANTHENE		440	UG/KG
SED120	20-Aug-91	METHYLENE CHLORIDE	B	17	UG/KG
SED120	20-Aug-91	PYRENE		510	UG/KG

1) B indicates that the chemical was also found in the associated blank as well as in the sample.

208/266

TABLE 2 34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

1 Aluminum, Dissolved

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
	SW018	8	49 47	72 54	130 00	17 00
	SW043	4	88 47	121 85	245 00	34 40
	SW085	6	84 42	124 32	200 00	30 00
	SW086	20	217 19	156 40	910 00	19.20
	SW093	16	120 94	103 52	457 00	10 00
	SW102	6	62 96	119 88	200 00	69 60
	SW118	5	75 10	69 38	184 00	10 00

Aluminum, Total

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
(mg/KG, sediments)	SW018	5	66 35	97 40	196 00	32 00
	SW043	3	304 66	706 67	940 00	362 00
	SW085	7	22889 46	12764 71	64100 00	886 00
	SW086	20	2807 60	1301 49	12500 00	27 00
	SW093	22	26494 73	14989 07	110000 00	71 00
	SW102	6	19662 30	11074 83	51000 00	299 00
	SW118	9	43696 94	31291.20	120000 00	83 80
	SED009	8	3095 55	5197 50	9130 00	1700.00
	SED010	1	N/A	2950 00	2950 00	2950 00
	SED118	6	2750 50	9173 33	14300 00	6250 00
	SED120	5	3611 49	8702 00	12400 00	2950 00

2 Antimony, Dissolved

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
	SW018	8	13 18	22.25	42.20	11 00
	SW043	4	20.26	31 95	62 00	18.20
	SW085	8	197 48	113.49	600.00	15 40
	SW086	22	101 92	55.29	500 00	9 10
	SW093	15	21 14	27 49	60 00	7 00
	SW102	6	183 10	130 00	500 00	26 00
	SW118	6	8 04	18 62	25 60	7 00

Antimony, Total

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
(mg/KG, sediments)	SW018	5	6 14	15 96	25 60	11 00
	SW043	3	3 70	21 93	25 60	18.20
	SW085	9	184 79	109 77	600 00	26 00
	SW086	22	122 79	60 68	600 00	1 50
	SW093	23	15 83	28 71	60 00	11 00
	SW102	6	183.96	128 68	500 00	26 00
	SW118	9	27.14	30 18	92 60	7 00
	SED009	8	2 73	4 94	9 90	1 60
	SED010	1	N/A	0 50	0 50	0 50
	SED118	6	3 99	6 92	13 30	2 40
	SED120	5	3 52	7 48	11 40	3 70

209/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

3 Arsenic, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	0 61	1 28	2 00	0 70
SW043	4	0 54	1.20	2.00	0.90
SW085	8	4 12	6 16	10 00	2 00
SW086	22	3 86	3 91	10 00	0 70
SW093	15	2 35	9 39	10 00	0 90
SW102	6	4 38	6 00	10 00	2 00
SW118	6	0 60	1 45	2 00	0 90

Arsenic, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1.27	1 96	4 00	0 90
SW043	3	0 06	0 93	1 00	0 90
SW085	11	6 80	8 88	27.20	2 80
SW086	22	6 13	5.20	27 00	0 70
SW093	23	2 84	3 56	10 00	0 80
SW102	6	3 99	6 50	10 00	2 00
SW118	9	1 89	2 77	5 80	0 90
SED009	8	1 51	2 66	5 10	1 10
SED010	1	N/A	0 50	0 50	0.50
SED118	6	2.07	6.25	10.20	4.60
SED120	5	1.22	3 94	5 10	1 90

4 Barium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	18 48	119 81	140 00	90 80
SW043	4	18 12	125 75	142 00	100 00
SW085	7	54.23	152 54	200 00	72 80
SW086	22	46 50	114 80	200 00	43 00
SW093	15	42 47	146 18	200 00	83 00
SW102	6	79 84	135 65	224 00	2 00
SW118	6	19 48	105 37	130 00	85.20

Barium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	15 72	129 00	140 00	102 00
SW043	3	12.29	138 00	147 00	124 00
SW085	10	638 66	498.20	1890 00	121.00
SW086	22	52.73	128 11	230 00	49 60
SW093	23	203 49	225 52	1000.00	83 10
SW102	6	193 74	227 73	590.00	2.39
SW118	9	620.27	459 06	1980 00	91.50
SED009	8	43 48	71 04	143 00	24.90
SED010	1	N/A	11 00	11 00	11 00
SED118	6	38 04	112 98	188 00	83 40
SED120	5	52.34	106 50	184 00	42 50

210/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

5 Beryllium, Dissolved

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
	SW018	9	0 30	0 81	1 40	0 50
	SW043	4	2 14	1 80	5 00	0 60
	SW085	7	2 10	3 36	5 00	0 50
	SW086	21	21 46	6 63	100 00	0 50
	SW093	18	1 77	2 39	5 00	0 50
	SW102	6	39 72	19 00	100 00	1 00
	SW118	7	0 52	0 94	2 00	0 50

Beryllium, Total

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
(mg/KG, sediments)	SW018	7	0 61	1 10	2 40	0 60
	SW043	3	0.23	0 73	1 00	0 60
	SW085	11	16 73	9 85	57 40	0 50
	SW086	22	20 91	6 71	100 00	0 50
	SW093	28	1 68	2.22	6 80	0 50
	SW102	6	39 40	19 65	100 00	1 00
	SW118	11	3 02	2 73	10 80	0 50
	SED009	8 00	0.22	0 41	0 90	0.20
	SED010	1 00	N/A	0 50	0 50	0 50
	SED118	7	0.25	0 79	1.20	0 44
	SED120	5	0.29	0 66	1 00	0.21

6 Cadmium, Dissolved

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
	SW018	5	1 04	3 52	4 60	2.40
	SW043	4	1 18	4 00	5 00	2 70
	SW085	7	1 11	4 36	5 00	2 00
	SW086	19	22.21	8 44	100 00	1 40
	SW093	12	1 40	3 18	5 00	2 00
	SW102	6	39 38	19 67	100 00	2 00
	SW118	5	0 54	2 78	3 30	2 00

Cadmium, Total

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(ug/L, water)						
(mg/KG, sediments)	SW018	2	0 42	3 00	3.30	2.70
	SW043	3	1 19	3 67	5 00	2.70
	SW085	11	10 05	8 81	34 10	2.00
	SW086	19	22 15	8 68	100 00	1 70
	SW093	18	1 41	3 59	5 80	2 00
	SW102	6	38 77	21 05	100 00	2 00
	SW118	7	2 74	4 00	9 80	2 00
	SED009	8	0 30	0 83	1 30	0 40
	SED010	1	N/A	0 50	0 50	0 50
	SED118	5	0 31	1 02	1 50	0 68
	SED120	5	0 51	1 09	1 90	0 56

211/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

7 Calcium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	8206 43	77362 50	84000 00	59400 00
SW043	4	17925 66	66975 00	92800 00	52500 00
SW085	7	17318 58	64600 00	94500 00	40300 00
SW086	22	18998 48	71304 55	106000.00	35300 00
SW093	16	20798 75	82456.25	116000 00	41400 00
SW102	6	24320 48	87616 67	128000 00	57500 00
SW118	6	9453 34	57516 67	67200 00	46000.00

Calcium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	10962 12	79560 00	89000 00	60800 00
SW043	3	4125 93	59366 67	63200 00	55000 00
SW085	10	264950 49	198634.24	700000 00	42 40
SW086	22	23888 44	66512.46	94100.00	74 10
SW093	23	26448 16	63421 74	108000 00	24000 00
SW102	6	26603.28	99866 67	137000 00	74400.00
SW118	9	21121 89	56577 78	101000 00	25000 00
SED009	8	5513 89	7243 75	14600 00	1370.00
SED010	1	N/A	3990 00	3990 00	3990.00
SED118	6	1985 73	8670 00	12000 00	6730 00
SED120	5	11335.29	16238 00	26300 00	3030 00

8 Cesium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	231.19	332.50	500 00	50 00
SW043	4	175.00	412 50	500 00	150 00
SW085	6	1050.84	1593.33	2500 00	60 00
SW086	20	928 37	821 15	2500 00	50 00
SW093	16	833 82	581 50	2500 00	50 00
SW102	5	1074.20	579 40	2500 00	50 00
SW118	6	214 49	321 00	500 00	50 00

Cesium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	244 68	232 00	500 00	50 00
SW043	3	0 00	500 00	500 00	500 00
SW085	9	995 60	1283.34	2500 00	0 10
SW086	19	954 94	832 63	2500 00	50 00
SW093	18	778 80	477 00	2500 00	50 00
SW102	6	989 48	482 83	2500 00	0 00
SW118	9	216 47	233.22	500 00	1 00
SED009	9	51 79	98 00	156 00	8 80
SED010	1	N/A	27 00	27 00	27 00
SED118	6	65 46	78 60	150.00	2 60
SED120	5	50.58	89.72	136.00	3 10

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

9 Chromium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	2 06	4 53	6 90	2 00
SW043	4	2 45	6 95	10 00	4 00
SW085	8	5 00	9 34	20 00	4 40
SW086	22	20.22	11 47	100 00	2 00
SW093	15	4 64	6 75	19 40	2 00
SW102	6	37 04	25 17	100 00	5 00
SW118	6	5 85	7 03	18 50	2 00

Chromium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	2 68	3 96	6 90	2 00
SW043	3	1 67	5 93	6 90	4 00
SW085	11	71.25	39 85	240 00	2 60
SW086	21	23 63	15.24	100 00	2 00
SW093	23	24 18	20 11	99 00	2 00
SW102	6	36 79	32 83	100 00	6 00
SW118	9	43 56	35 36	130 00	4 10
SED009	8	4 07	6 10	11 80	1 30
SED010	1	N/A	4 70	4 70	4 70
SED118	6	2 00	8 08	11 30	5 80
SED120	5	4 47	9 16	15.20	4 80

10 Cobalt, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	2.20	3 84	7 30	2 00
SW043	4	23.24	15 15	50 00	3 00
SW085	8	23 07	28 99	50 00	3 70
SW086	22	25 71	17 62	100 00	2 00
SW093	15	21 33	15 84	50 00	2 00
SW102	6	36 79	38 00	100 00	4 00
SW118	6	1 31	3 52	5 90	2 00

Cobalt, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	0 74	2 52	3.60	2 00
SW043	3	0 50	3 53	4 00	3 00
SW085	11	34.53	43 83	117 00	4 00
SW086	22	26.21	20.20	100 00	2 00
SW093	23	17 66	15 99	53 00	2 00
SW102	6	33 03	43.23	100 00	4 00
SW118	9	27 68	18 96	87 10	3 00
SED009	8	2 07	5 50	8 20	2 40
SED010	1	N/A	5 40	5 40	5 40
SED118	6	3 78	7 70	15 00	4 70
SED120	5	2 67	5 44	9 60	2.20

213/266

TABLE 2 34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

11 Copper, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	3 77	4 90	13 60	2 00
SW043	4	7 36	11 60	20 00	4 70
SW085	8	9 53	17 41	25 00	3 00
SW086	21	21.22	15 13	100 00	1 30
SW093	15	9 88	9.26	25 00	2 00
SW102	6	35 73	29 73	100 00	3 40
SW118	6	4 28	5 33	13 80	2 00

Copper, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	6 90	7 34	19 00	2 00
SW043	3	0 74	5.27	6 10	4 70
SW085	11	9.23	21 13	33.20	0.23
SW086	21	21 62	19 66	100 00	3 00
SW093	23	32 14	28.27	120 00	2 00
SW102	6	41 71	46 63	100 00	9 80
SW118	9	62.28	43 30	192 00	2 00
SED009	8	4 03	10 40	15 60	5 60
SED010	1	N/A	0 42	0 42	0 42
SED118	6	9 38	16 90	35 90	11 10
SED120	5	2 72	13.88	18 50	11 40

12 Iron, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	105 22	120 99	240 00	8 50
SW043	4	117 88	192 00	330 00	42 00
SW085	6	31 33	77 00	100 00	33 30
SW086	21	355 89	202.89	1320.00	15 60
SW093	16	223 46	192 89	750 00	6 00
SW102	6	32 53	92 32	127 00	31.90
SW118	6	27 53	65 17	97 00	20 60

Iron, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	190 14	280 40	480 00	20 00
SW043	3	455 75	924 33	1340 00	437 00
SW085	11	74763 58	30733 45	253000 00	548 00
SW086	22	4721 19	2227 07	21800 00	27 00
SW093	23	27358 87	16052.22	110000 00	488 00
SW102	6	16845 75	10354 00	44400 00	344 00
SW118	9	53371 81	35460 56	156000 00	149 00
SED009	8	3262 37	9585.00	14500 00	6130.00
SED010	1	N/A	5280 00	5280 00	5280 00
SED118	6	3982 80	14033 33	21700 00	10800 00
SED120	5	4168 39	12364 00	16200 00	5620 00

214/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

13 Lead, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	0 52	1 30	2 40	0 80
SW043	4	4.27	3 75	10 00	1 00
SW085	7	14 20	9 33	40 80	1 00
SW086	23	20 37	7.24	100 00	0 90
SW093	15	25 41	8.23	100 00	0 40
SW102	7	10 45	6 43	30 00	1 00
SW118	6	0.26	1.23	1 50	1 00

Lead, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	0 34	2 74	3 20	2 40
SW043	3	0 78	2.20	2 70	1 30
SW085	9	6 05	9 46	19 50	3 80
SW086	22	10 97	8 02	50 00	0 80
SW093	23	34 44	28 81	100 00	0 70
SW102	7	31 57	19 14	90.20	3 00
SW118	9	35.28	25 66	103 00	1 00
SED009	8	6 76	11 35	21 50	2 50
SED010	1	N/A	7 60	7 60	7 60
SED118	6	2 84	16 18	21 60	13 60
SED120	5	21 16	22.96	59 40	5 60

14 Lithium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	1 13	6 40	8 10	4 30
SW043	3	2 06	7 63	10 00	6 30
SW085	6	41 45	73 38	100 00	13 40
SW086	21	45 43	48 85	100 00	6 00
SW093	16	41 22	42.24	100 00	3 70
SW102	4	42 74	73 00	100.00	10.20
SW118	6	5 17	11 85	20 00	7 40

Lithium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1 67	7.22	8 40	4 30
SW043	3	2 87	6 97	10 00	4 30
SW085	9	50 36	89 55	178 00	0 11
SW086	20	45 08	51 56	100 00	5 90
SW093	18	114 68	60 77	500.00	5 80
SW102	4	28 75	82 43	100 00	39 90
SW118	9	24 58	26 76	84 50	7 40
SED009	7	2 03	4 19	6 90	1 80
SED010	0	N/A	N/A	N/A	N/A
SED118	6	2 12	8 02	11.20	6 00
SED120	8	1 13	6 40	8 10	4 30

215/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

15 Magnesium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	1807 92	15150 00	17700 00	11500 00
SW043	4	2744 65	10257 50	14300 00	8250 00
SW085	7	4806 68	9012 40	15600 00	16 80
SW086	22	2744 67	10615 00	15900 00	5490 00
SW093	16	7269 39	18655 63	27100 00	10 00
SW102	6	42743 03	40666 67	123000 00	10300 00
SW118	6	2617 38	14633 33	17500 00	11000 00

Magnesium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	2413 92	15880 00	17700 00	11700 00
SW043	3	594 05	9000 00	9550 00	8370.00
SW085	10	16538 83	20751 00	60800 00	9090 00
SW086	22	3684 40	10935 45	21300 00	5560 00
SW093	23	6950 13	16176 96	31000 00	5770 00
SW102	6	10075 05	23266 67	37900 00	14000 00
SW118	9	11834 71	20255 56	50000 00	12000 00
SED009	8	815 85	1494 00	2660 00	713 00
SED010	1	N/A	2480 00	2480 00	2480 00
SED118	6	107 61	273 67	457.00	189.00
SED120	5	753.34	2298 00	2920 00	1100 00

16 Manganese, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	35 12	149 88	204 00	100 00
SW043	4	668 53	458 70	1450 00	6 80
SW085	8	79 52	39 60	236 00	2 30
SW086	22	28 11	49 67	106 00	10 10
SW093	16	414 43	555 66	1420 00	76 70
SW102	7	38 38	33 54	100 00	1 10
SW118	6	7 78	13.22	26 60	5 40

Manganese, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	20 45	148.00	170 00	120 00
SW043	3	192 72	188 73	408 00	46.20
SW085	11	1068 39	537 70	2930 00	11 30
SW086	22	60.27	68.23	281 00	14.20
SW093	23	474 18	620 90	2100 00	87 80
SW102	5	739 42	408 72	1730 00	38 70
SW118	9	1195 51	721 74	3640 00	7 50
SED009	8	479 80	742.25	1700 00	241.00
SED010	1	N/A	340 00	340 00	340 00
SED118	6	107 61	273 67	457 00	189 00
SED120	5	93 46	197 04	339 00	84.20

216/266

TABLE 2 34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

17 Mercury, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	0 00	0.20	0 20	0 20
SW043	4	0 03	0.22	0.26	0.20
SW085	7	0 07	0.24	0 34	0.20
SW086	22	0 17	0.25	1 00	0 20
SW093	15	0 10	0.20	0 54	0 10
SW102	7	0 05	0.22	0 34	0.20
SW118	6	0 00	0.20	0 20	0.20

Mercury, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	0 00	0.20	0.20	0 20
SW043	3	0 00	0.20	0 20	0 20
SW085	11	0 07	0.25	0 39	0.20
SW086	23	0 19	0.25	1 10	0 20
SW093	21	0 08	0.21	0 40	0 10
SW102	7	0 09	0.25	0 43	0.20
SW118	9	0 07	0.22	0 41	0.20
SED009	9	0 06	0 13	0 27	0 09
SED010	1	N/A	0 11	0 11	0 11
SED118	7	0 16	0.20	0 50	0 10
SED120	5	0 03	0 11	0 16	0 08

18 Molybdenum, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	3.29	6 55	10 90	3 00
SW043	4	45 69	31 53	100 00	6.20
SW085	6	40 79	74 17	100 00	10 00
SW086	21	44 80	50 50	100 00	2.20
SW093	16	42 17	47 19	100 00	3 00
SW102	4	47 10	60 45	100 00	6 80
SW118	6	3.35	5.98	10.90	2 00

Molybdenum, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	4 30	6 46	11 40	3 00
SW043	3	2 63	8 53	10 90	5 70
SW085	9	46 94	89 12	167 00	0 10
SW086	21	45 85	53 65	100 00	2 00
SW093	18	230 33	88 56	1000.00	3.00
SW102	4	47 10	60 45	100 00	6 80
SW118	9	8 84	12 07	26 00	2 00
SED009	8	1 99	3 60	7 90	1 30
SED010	1	N/A	11 00	11 00	11 00
SED118	6	2.27	2 93	7.20	0 66
SED120	5	0 50	2 40	3 10	1 80

217/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

19 Nickel, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	4.15	8.36	14.70	3.90
SW043	4	16.02	16.90	40.00	3.90
SW085	7	15.73	27.86	40.00	6.00
SW086	19	23.93	19.86	100.00	3.80
SW093	15	15.36	15.93	40.00	4.00
SW102	6	35.50	35.00	100.00	4.00
SW118	6	5.27	8.42	14.70	3.90

Nickel, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	4.73	7.52	14.70	3.90
SW043	3	5.40	9.20	14.70	3.90
SW085	11	79.32	49.18	284.00	0.14
SW086	19	23.99	23.95	100.00	3.80
SW093	23	24.58	25.63	100.00	4.00
SW102	6	32.27	44.08	100.00	7.90
SW118	9	58.06	42.27	183.00	3.90
SED009	8	4.20	8.33	14.80	3.20
SED010	1	N/A	4.30	4.30	4.30
SED118	6	5.22	14.07	24.30	10.80
SED120	5	6.27	11.24	19.70	2.60

20 Potassium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	640.19	2751.25	4150.00	2100.00
SW043	4	1018.15	1997.75	3380.00	991.00
SW085	7	2911.72	18914.29	25300.00	16800.00
SW086	22	1941.47	5433.18	12400.00	2740.00
SW093	15	790.00	3976.00	5000.00	2810.00
SW102	6	3319.00	9350.00	13300.00	3720.00
SW118	6	579.85	2215.00	3000.00	1460.00

Potassium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1052.73	3280.00	4700.00	2000.00
SW043	3	355.01	1693.33	2050.00	1340.00
SW085	10	15309.70	25170.00	62200.00	14300.00
SW086	22	1870.20	5468.18	12000.00	2750.00
SW093	23	3470.98	5552.17	18000.00	1620.00
SW102	6	4782.43	11105.00	17000.00	4160.00
SW118	9	5520.95	6022.22	17200.00	1700.00
SED009	8	449.67	939.88	1510.00	402.00
SED010	1	N/A	550.00	550.00	550.00
SED118	6	415.34	1315.00	2130.00	1000.00
SED120	5	407.38	1380.20	1730.00	791.00

218/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

21 Selenium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	1 44	2.26	4 00	1 10
SW043	4	3 18	2 98	7 70	1 10
SW085	8	1 90	3 91	6 00	1 00
SW086	23	2 65	4 26	10 00	1 80
SW093	16	4 95	4 89	18 40	1 00
SW102	7	3 15	5 71	10 00	2 00
SW118	6	1 18	1 72	4 00	1 00

Selenium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1 59	2 84	4 00	1 10
SW043	3	0 52	1 40	2 00	1 10
SW085	11	3 78	4 95	15 00	1 30
SW086	23	2 93	4 42	10 00	1 30
SW093	23	4 83	3.97	20 00	1 00
SW102	7	4 43	7 43	15 00	2 00
SW118	9	4 50	3.26	15 00	1 00
SED009	8	0 08	0 26	0 35	0 10
SED010	1	N/A	0 04	0 04	0 04
SED118	6	0.25	0 51	0 94	0 31
SED120	5	0 16	0 36	0 61	0.23

22 Silicon, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	9	957 64	6143 33	7480 00	4450 00
SW043	2	417 19	7865 00	8160 00	7570 00
SW085	1	N/A	3000 00	3000 00	3000 00
SW086	8	996 71	6296.25	7510 00	4430 00
SW093	10	1141 95	6002 00	7450 00	3720 00
SW102	0	N/A	N/A	N/A	N/A
SW118	8	1255 31	5141.25	6140 00	2590 00

Silicon, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	3	595 34	5463 33	5920 00	4790 00
SW043	2	940 45	8305 00	8970 00	7640 00
SW085	1	N/A	4380 00	4380 00	4380 00
SW086	3	591 02	5280 00	5960 00	4890 00
SW093	5	1970 16	6132 00	9070 00	4110 00
SW102	0	N/A	N/A	N/A	N/A
SW118	4	1452 08	4340 00	6000 00	2500 00
SED009	5	189 32	380 40	689 00	241 00
SED010	0	N/A	N/A	N/A	N/A
SED118	4	552 37	712 50	1320 00	214 00
SED120	4	440 72	661 00	1190 00	168 00

219/266

TABLE 2.34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

23 Silver, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	1 94	4 29	6 80	2 00
SW043	4	3 14	5 45	10 00	3 00
SW085	8	8 33	10 58	30 00	2 40
SW086	22	20 82	10 67	100 00	2 00
SW093	15	3 16	5 49	10 00	2 00
SW102	6	37 36	26 33	100 00	2 00
SW118	6	1 61	4.22	6 50	2 00

Silver, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1 51	3 56	5 00	2 00
SW043	3	1 01	3 93	5 00	3 00
SW085	11	30 75	20 59	111 00	6 00
SW086	22	20 77	10 93	100 00	2 00
SW093	23	2 56	4 84	10 00	2 00
SW102	6	37 07	26 72	100 00	4 30
SW118	9	1 30	3 76	5 00	2 00
SED009	8	0 39	0 95	1 60	0 55
SED010	1	N/A	1 10	1 10	1 10
SED118	6	0 71	1 41	2 30	0 44
SED120	5	1 00	1 55	3 10	0 59

24 Sodium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	3818 38	29800 00	37100 00	26000 00
SW043	4	3789 90	20650 00	26100 00	17400 00
SW085	6	93181 44	144100 00	334000 00	97600 00
SW086	22	8898 94	39045 45	53700 00	20300 00
SW093	16	14029 54	44700 00	84800 00	22000 00
SW102	6	60306.23	108583 33	219000 00	58300 00
SW118	6	4941 93	34566 67	41400 00	30000 00

Sodium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	2941 43	32280 00	36800 00	29000 00
SW043	3	896.29	18833 33	19400 00	17800 00
SW085	10	71325 29	139120 00	295000 00	82700 00
SW086	22	9560 89	38072 73	50600 00	19200 00
SW093	23	18244 69	32330 43	87400 00	8800 00
SW102	6	47032.50	100900 00	181000 00	60200 00
SW118	9	11481 40	31800 00	51100 00	16000 00
SED009	8	88 46	155.26	298 00	60 30
SED010	1	N/A	54 00	54 00	54 00
SED118	6	120 76	233 33	402 00	112 00
SED120	5	289 05	407 80	742 00	113 00

220/266

TABLE 2 34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

25 Strontium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	48 21	430 88	480 00	336 00
SW043	3	1 53	237 67	239 00	236 00
SW085	7	259 08	505 00	1000 00	263 00
SW086	22	272 92	457 55	1000 00	170 00
SW093	16	243 71	590.25	1000 00	243 00
SW102	6	308 88	630 00	1070 00	343 00
SW118	6	59 43	360 83	422 00	289 00

Strontium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	58 97	440 00	480 00	336 00
SW043	3	1 53	237 67	239 00	236 00
SW085	10	529 06	769 80	1770 00	321 00
SW086	21	275 56	472 38	1000 00	172 00
SW093	18	211 92	456 11	1000 00	140 00
SW102	6	216 57	645 17	980 00	425 00
SW118	9	149 59	389 00	739 00	190 00
SED009	8	16 88	26 71	49 90	5 50
SED010	1	N/A	15 00	15 00	15 00
SED118	6	14 01	46 35	74 80	38 10
SED120	5	18 90	45 84	64 80	18 50

26 Thallium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	1 31	2 11	5 00	1 00
SW043	4	4.21	3 70	10 00	1 40
SW085	8	103 91	43 05	300 00	1 00
SW086	23	6 35	5 67	30 00	1 00
SW093	15	4 48	5.20	15 00	0 60
SW102	6	119 76	55 67	300 00	1 00
SW118	6	5 46	3 87	15 00	1 40

Thallium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1.27	1 76	4 00	1 00
SW043	3	0 35	1 60	2 00	1 40
SW085	10	92 98	35 63	300 00	1 00
SW086	23	6 48	5 73	30 00	1 00
SW093	23	2 94	2 84	10 00	1 00
SW102	6	119 76	55 67	300 00	1 00
SW118	9	0 77	1 80	3 00	1 00
SED009	8	4 43	2 05	13 00	0 27
SED010	1	N/A	0 11	0 11	0 11
SED118	6	0 39	0 61	1 40	0 41
SED120	5	0 14	0 43	0 61	0.28

TABLE 2 34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

27 Tin, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	11 94	21 70	38 90	10 40
SW043	3	3.35	26 13	30 00	24.20
SW085	6	30 62	87 50	100 00	25 00
SW086	21	39.24	64 19	100 00	11 00
SW093	16	38 97	44 69	100 00	11 00
SW102	4	40 89	64 73	100 00	25 00
SW118	8	11 94	21 70	38 90	10 40

Tin, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	6 55	17 08	24 20	11 00
SW043	3	3 35	26 13	30 00	24.20
SW085	9	44 59	70 57	100 00	0 10
SW086	21	38 43	68 41	100 00	11 00
SW093	18	464 06	144 65	2000 00	11 00
SW102	4	40 62	65 00	100 00	25 00
SW118	9	27 14	31 09	94 60	12 00
SED009	7	2 49	7 17	10 70	3 70
SED010	0	N/A	N/A	N/A	N/A
SED118	6	7 43	11.23	24 90	2 90
SED120	5	5 43	6 96	14 80	0 08

28 Vanadium, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	2 18	3 63	6 50	2 00
SW043	4	10 83	8 93	25 00	2 00
SW085	8	22 83	28 69	50 00	5 40
SW086	21	25 58	19 13	100 00	2 00
SW093	15	20 61	17 13	50 00	2 00
SW102	6	37 08	37.23	100 00	6 00
SW118	6	2 50	4 43	8.20	2.00

Vanadium, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	1 65	2 74	5 70	2 00
SW043	3	2 03	4 33	5 70	2 00
SW085	11	198.27	117.27	677 00	8 10
SW086	20	26 61	23 85	100 00	2.10
SW093	23	59 65	44 87	250 00	3 90
SW102	6	50 83	60 48	140 00	10 00
SW118	9	106 61	78.21	305 00	2 00
SED009	8	8 43	16.26	27 60	6 70
SED010	1	N/A	13 00	13 00	13 00
SED118	6	8 85	25 07	42 40	17 50
SED120	5	9 42	25 62	37 90	12 30

222/266

TABLE 2 34
SUMMARY STATISTICS - SELECTED TRACE METALS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

A Trace Metals, Surface-Water Sites

29 Zinc, Dissolved

(ug/L, water)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	8	7 91	13 05	27 00	4 30
SW043	4	230 18	138 35	483 00	10 20
SW085	7	25 83	26 63	82 50	5 40
SW086	22	50 77	72.27	219 00	4 90
SW093	16	70 13	42 77	297 00	3 00
SW102	6	128 83	133 50	349 00	16 80
SW118	6	101 76	50 38	258 00	3 30

Zinc, Total

(ug/L, water)
(mg/KG, sediments)

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	8 31	16 42	24 60	5 00
SW043	3	23 85	23 57	50 60	5 50
SW085	11	868 94	528 10	2460 00	45 40
SW086	22	331.23	288 91	1540 00	7.20
SW093	23	217 95	204 84	750 00	31 00
SW102	6	1593 00	1052 55	4240 00	41 30
SW118	7	140 35	94 96	380 00	4 30
SED009	8	46 65	87 49	158 00	32 10
SED010	1	N/A	23 00	23 00	23 00
SED118	6	22 83	67 15	111 00	49.60
SED120	5	21.22	80 50	102 00	47 40

223/266

TABLE 2.35
SUMMARY STATISTICS - SELECTED RADIONUCLIDES, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

GROSS ALPHA - DISSOLVED

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(pCi/l - Water)	SW018	2	2 666	4 810	6 695	2 924
	SW043	4	1 666	3 050	5 500	2 000
	SW056	13	3 829	4 602	16 120	0 142
	SW059	13	4 856	6 321	17 070	2 362
	SW084	7	1 759	4 367	6 781	2 000
	SW085	1	N/A	13 100	13 100	13 100
	SW086	9	1 472	2 492	4 900	0 000
	SW093	6	5 989	6 766	18 860	3 000
	SW102	2	16 285	14 905	26 420	3 390
	SW118	6	1 454	2 935	5 709	1 820
	SW122	7	3 041	4 660	10 000	1 183
	SW124	2	3 520	7 500	10 000	5 000

GROSS ALPHA - TOTAL

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(pCi/l - Water)	SW018	0	N/A	N/A	N/A	N/A
(pCi/g Sediment)	SW043	1	N/A	6 000	6 000	6 000
	SW056	23	41 517	19.281	200 000	-0.021
	SW059	18	75 954	33 516	310 000	-0.300
	SW084	8	9 666	6 819	30 400	1 800
	SW085	5	94 713	89 308	240 000	8 600
	SW086	17	10 069	7 450	44 000	1 100
	SW093	16	20 125	18 687	74 970	3 520
	SW102	2	53 075	48 760	86.290	11.230
	SW118	8	27 325	18 028	79.000	-0 084
	SW122	2	0 159	2 313	2.425	2.200
	SW124	0	N/A	N/A	N/A	N/A
	SED009	7	21 881	18 489	67 000	4.200
	SED010	1	N/A	10 000	10 000	10 000
	SED011	8	11 943	14 567	36 000	0 400
	SED012	2	3 54	26 50	29 00	24 00
	SED118	5	9 073	12 170	28 000	5.212
	SED120	3	3 549	5 936	9 551	2 457
	SED124	2	3 430	11 890	14 320	9 470

224/266

TABLE 2.35
SUMMARY STATISTICS - SELECTED RADIONUCLIDES, OU8 AREA
SURFACE-WATER AND SEDIMENT SITES

GROSS BETA - DISSOLVED

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(pCi/l - Water)	SW018	2	3 948	8 948	11 740	6 156
	SW043	4	1 977	4 900	7 800	3 400
	SW056	13	2 390	6 062	12.290	1 703
	SW059	13	3 012	4 749	11 000	-2 000
	SW084	7	1 960	6 510	10 580	4 780
	SW085	1	N/A	43 300	43 300	43 300
	SW086	10	1 390	5 470	7.200	3 868
	SW093	7	2 938	8 668	13 520	4 701
	SW102	2	0 566	24 300	24 700	23 900
	SW118	6	2 747	4 861	10.230	3 005
	SW122	7	32 963	17 498	92 000	1 825
	SW124	2	7 071	10 000	15 000	5 000

GROSS BETA - TOTAL

	Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
(pCi/l Water)	SW018	0	N/A	N/A	N/A	N/A
(pCi/g Sediment)	SW043	1	N/A	5 000	5 000	5 000
	SW056	23	16 517	12 616	79 000	-0 630
	SW059	17	81 903	34 617	340 000	0.500
	SW084	7	5 513	7 969	19.200	2.200
	SW085	5	63 060	61 436	170 000	13 700
	SW086	16	6 706	10 173	33 000	4 700
	SW093	16	21 650	23 129	87 830	7 490
	SW102	2	22 917	37 765	53 970	21 560
	SW118	8	36 312	23 486	110 000	1 792
	SW122	2	0 737	7 921	8 442	7 400
	SW124	0	N/A	N/A	N/A	N/A
	SED009	7	5 687	27 481	38 000	23 030
	SED010	1	N/A	28 000	28 000	28 000
	SED011	8	10 039	20 543	32 000	-0 300
	SED012	2	11 31	14 00	22 00	6 00
	SED118	5	6 199	27.396	37 000	19 790
	SED120	3	124 669	96 447	240 400	23 880
	SED124	2	4 900	29 480	32 940	26 010

TABLE 2.36
SUMMARY STATISTICS - SELECTED WATER QUALITY PARAMETERS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

Nitrate/Nitrite

SW = mg/l
SED = mg/kg

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	6	0.48	1.60	2.10	0.89
SW043	5	8.32	7.67	22.14	2.10
SW085	15	71.31	71.82	247.91	15.00
SW093	24	2.09	2.98	8.30	0.40
SW102	9	19.15	18.61	68.62	4.80
SW118	13	0.61	0.45	1.80	0.02
SED009	10	107.74	46.53	345.31	1.10
SED010	1	N/A	20.00	20.00	20.00
SED011	9	12.21	5.63	38.10	0.60
SED118	5	1.89	3.46	6.30	1.40
SED120	3	79.85	77.30	163.00	5.00

Orthophosphate

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	7	0.01	0.05	0.05	0.02
SW043	2	0.00	0.05	0.05	0.05
SW085	0	N/A	N/A	N/A	N/A
SW093	12	0.02	0.04	0.07	0.01
SW102	1	N/A	0.04	0.04	0.04
SW118	10	0.02	0.03	0.05	0.01
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	0	N/A	N/A	N/A	N/A
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

Phosphate

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	0	N/A	N/A	N/A	N/A
SW043	2	0.03	0.04	0.06	0.02
SW085	0	N/A	N/A	N/A	N/A
SW093	11	0.25	0.12	0.84	0.01
SW102	1	N/A	0.18	0.18	0.18
SW118	4	0.01	0.02	0.04	0.01
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	0	N/A	N/A	N/A	N/A
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

226/266

TABLE 2.36
SUMMARY STATISTICS - SELECTED WATER QUALITY PARAMETERS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

Phosphorus

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std. Deviation	Mean	Maximum	Minimum
SW018	6	0.28	0 17	0 74	0 05
SW043	2	0 01	0 06	0 07	0 05
SW085	0	N/A	N/A	N/A	N/A
SW093	10	0 33	0 18	1 10	0 01
SW102	0	N/A	N/A	N/A	N/A
SW118	7	0 01	0 05	0 06	0 04
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	0	N/A	N/A	N/A	N/A
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

$CBOD_5$

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	4	0 52	6 28	6 90	5 80
SW043	4	14 50	16 65	29 50	3 80
SW085	0	N/A	N/A	N/A	N/A
SW093	2	0 07	7 55	7 60	7 50
SW102	0	N/A	N/A	N/A	N/A
SW118	3	0 57	5 37	6 00	4 90
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	0	N/A	N/A	N/A	N/A
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

Total Organic Carbon

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std. Deviation	Mean	Maximum	Minimum
SW018	7	0 91	3 70	4 60	2 00
SW043	4	0 41	3 50	3 90	3 10
SW085	0	N/A	N/A	N/A	N/A
SW093	6	1 19	4 08	5 30	3 00
SW102	0	N/A	N/A	N/A	N/A
SW118	3	0 42	4 43	4 90	4 10
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	0	N/A	N/A	N/A	N/A
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

TABLE 2.36
SUMMARY STATISTICS - SELECTED WATER QUALITY PARAMETERS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

Oil and Grease

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	6	2 62	7 30	12.20	5 30
SW043	3	1 03	5 87	7 00	5 00
SW085	11	96 40	30 36	321 00	1 00
SW093	14	3 43	3 66	11 60	0 30
SW102	8	154 46	56 74	439 00	1 00
SW118	8	3.25	5 53	8.20	0 30
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	2	424.26	1300 00	1600 00	1000 00
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

Bicarbonate as $CaCO_3$

SW = mg/l
SED = mg/kg

Sampling Site	No of Samples	Std. Deviation	Mean	Maximum	Minimum
SW018	6	54.28	227 33	288 00	145 00
SW043	3	44 66	163 33	210 00	121 00
SW085	11	226.32	342 73	1000 00	130 00
SW093	16	107 76	171 88	310 00	50 00
SW102	8	82 83	253 00	410 00	120 00
SW118	13	74 85	154 00	250 00	57 00
SED009	8	253 37	333 75	620 00	100 00
SED010	0	N/A	N/A	N/A	N/A
SED011	6	1703 08	2851 67	4800 00	440 00
SED118	0	N/A	N/A	N/A	N/A
SED120	1	N/A	270 00	270 00	270 00

Sulfate

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std. Deviation	Mean	Maximum	Minimum
SW018	6	4.24	34 50	40.20	29 00
SW043	4	15 80	40 75	54 00	18 00
SW085	11	18.22	54 18	95 00	28 00
SW093	26	24.26	34 96	120 00	8 00
SW102	8	49 62	118.25	219 00	61 00
SW118	13	6 39	17 88	29 00	9 00
SED009	1	N/A	289 00	289 00	289 00
SED010	1	N/A	26 00	26 00	26 00
SED011	1	N/A	173 00	173 00	173 00
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

TABLE 2.36
SUMMARY STATISTICS - SELECTED WATER QUALITY PARAMETERS, OU8 AREA SURFACE-WATER AND SEDIMENT SITES

Chloride

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	5	10 79	54 24	67 00	40 30
SW043	4	6 17	22.23	26 00	13 00
SW085	11	22 78	43 09	85 00	10 00
SW093	26	31 56	40 37	160 00	8 00
SW102	8	38 37	74 41	142 00	22 00
SW118	13	23 42	38 57	83 00	17 00
SED009	1	N/A	139 00	139 00	139 00
SED010	1	N/A	11 00	11 00	11 00
SED011	1	N/A	210 00	210 00	210 00
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

Fluoride, Soluble

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	6	0 06	0 54	0 64	0 48
SW043	3	0 04	0 31	0 36	0.28
SW085	0	N/A	N/A	N/A	N/A
SW102	2	0 04	0 77	0 80	0 74
SW118	6	0 05	0 46	0 53	0 39
SED009	0	N/A	N/A	N/A	N/A
SED010	0	N/A	N/A	N/A	N/A
SED011	0	N/A	N/A	N/A	N/A
SED118	0	N/A	N/A	N/A	N/A
SED120	0	N/A	N/A	N/A	N/A

Total Dissolved Solids

SW = mg/l
SED = N/A

Sampling Site	No of Samples	Std. Deviation	Mean	Maximum	Minimum
SW018	6	19 09	369 00	396 00	350 00
SW043	4	85.09	339.50	450 00	258 00
SW085	11	300 97	737.27	1500 00	440 00
SW093	26	176 62	316 88	680 00	100 00
SW102	7	191.17	574 14	910 00	290 00
SW118	13	89 19	259 08	372 00	130 00

Specific Conductivity

SW = umho
SED = N/A

Sampling Site	No of Samples	Std Deviation	Mean	Maximum	Minimum
SW018	0	N/A	N/A	N/A	N/A
SW043	0	N/A	N/A	N/A	N/A
SW085	1	N/A	1630 00	1630 00	1630 00
SW093	0	N/A	N/A	N/A	N/A
SW102	1	N/A	1019 00	1019 00	1019 00
SW118	0	N/A	N/A	N/A	N/A

229/266

TABLE 2.37

IHSS CLUSTERS AND CONSTITUENTS FOR SURFACE-WATER AND SEDIMENT ANALYSIS

Cluster No.	IHSSs	Constituents	Water Shed
I	135	A,B,C	North Walnut Creek
	150.2	A	North Walnut Creek
	150.7	A	North Walnut Creek
	151	D	North Walnut Creek
	188	C	North Walnut Creek
Total		A,B,C,&D	
II	118.1	D	North Walnut Creek
	137	B	North Walnut Creek
	138	A,B,C	North Walnut Creek
	139.1 (N)	B	North Walnut Creek
	139.1 (S)	B	North Walnut Creek
	139.2	C	North Walnut Creek
	144	A	North Walnut Creek
	150.1	A	North Walnut Creek
	150.3	A	North Walnut Creek
	150.6	A	North Walnut Creek
	150.7	A	North Walnut Creek
	150.8	A	North Walnut Creek
	163.1	A,C,D	North Walnut Creek
	163.2	A	North Walnut Creek
Total		A,B,C,&D	
III	118.2	D	South Walnut Creek
	123.1	A	South Walnut Creek
	150.4	A	South Walnut Creek
	150.7	A	South Walnut Creek
	172	A,D	South Walnut Creek
	173	A,D	South Walnut Creek
	184	A	South Walnut Creek
Total		A,D	

A - Radionuclides B - Trace Metals C - Inorganics D - Volatile Organics

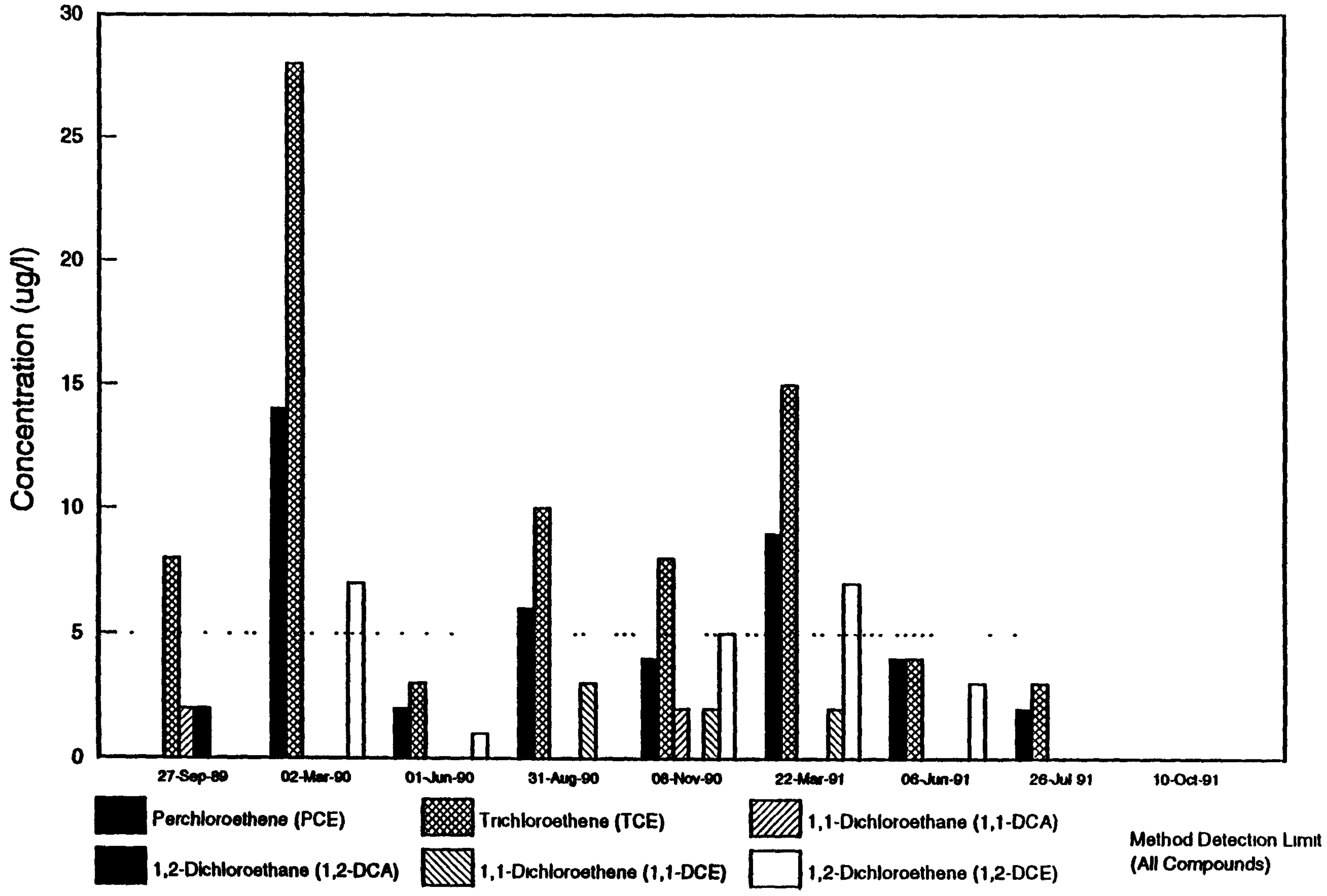

FIGURE 2-28

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER SAMPLES FROM WELL P209189

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN
U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

230/266

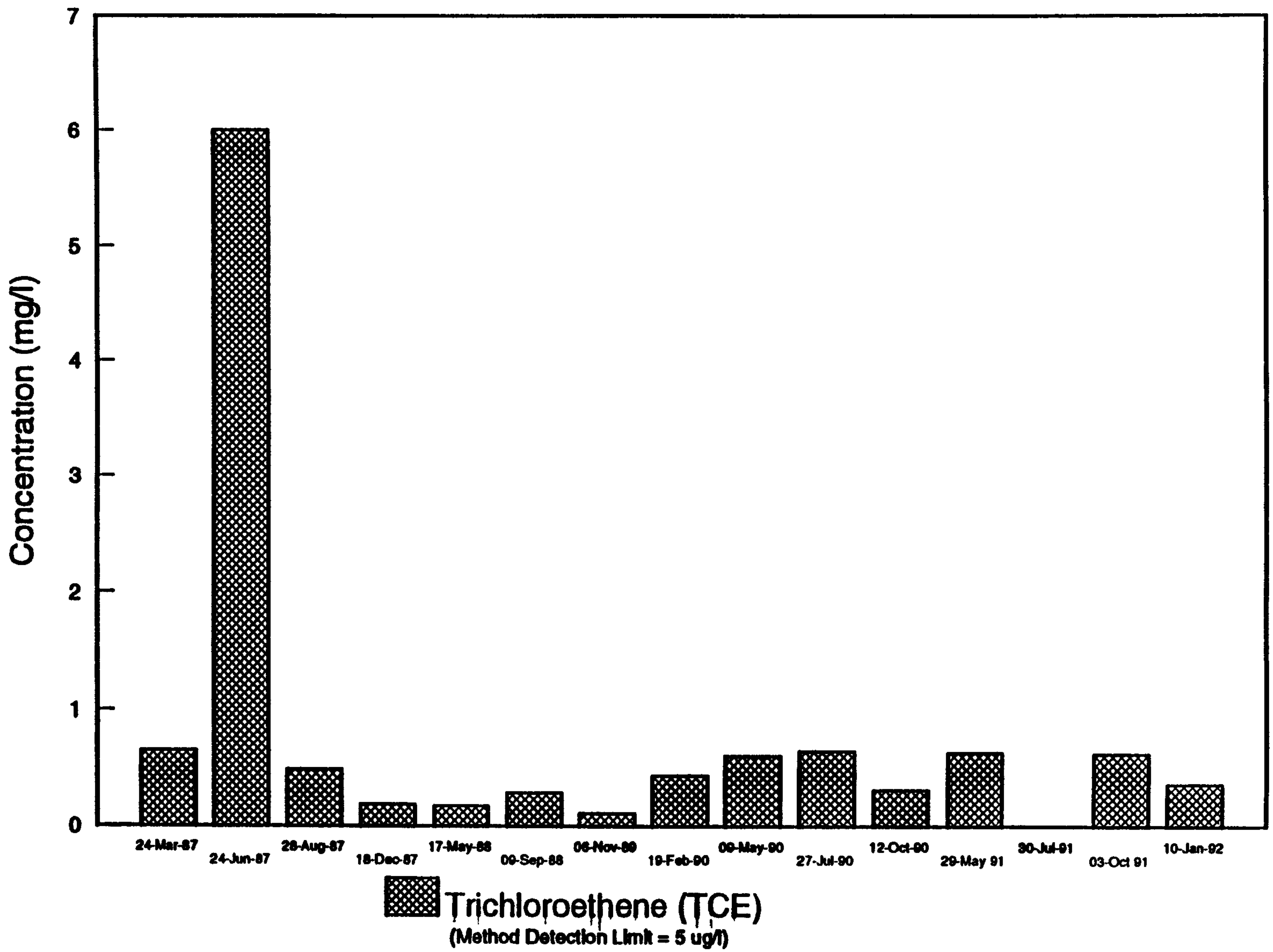

FIGURE 2-29

TRICHLOROETHENE CONCENTRATIONS IN GROUNDWATER SAMPLES FROM WELL 2286

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN
U S DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden Colorado

231/266

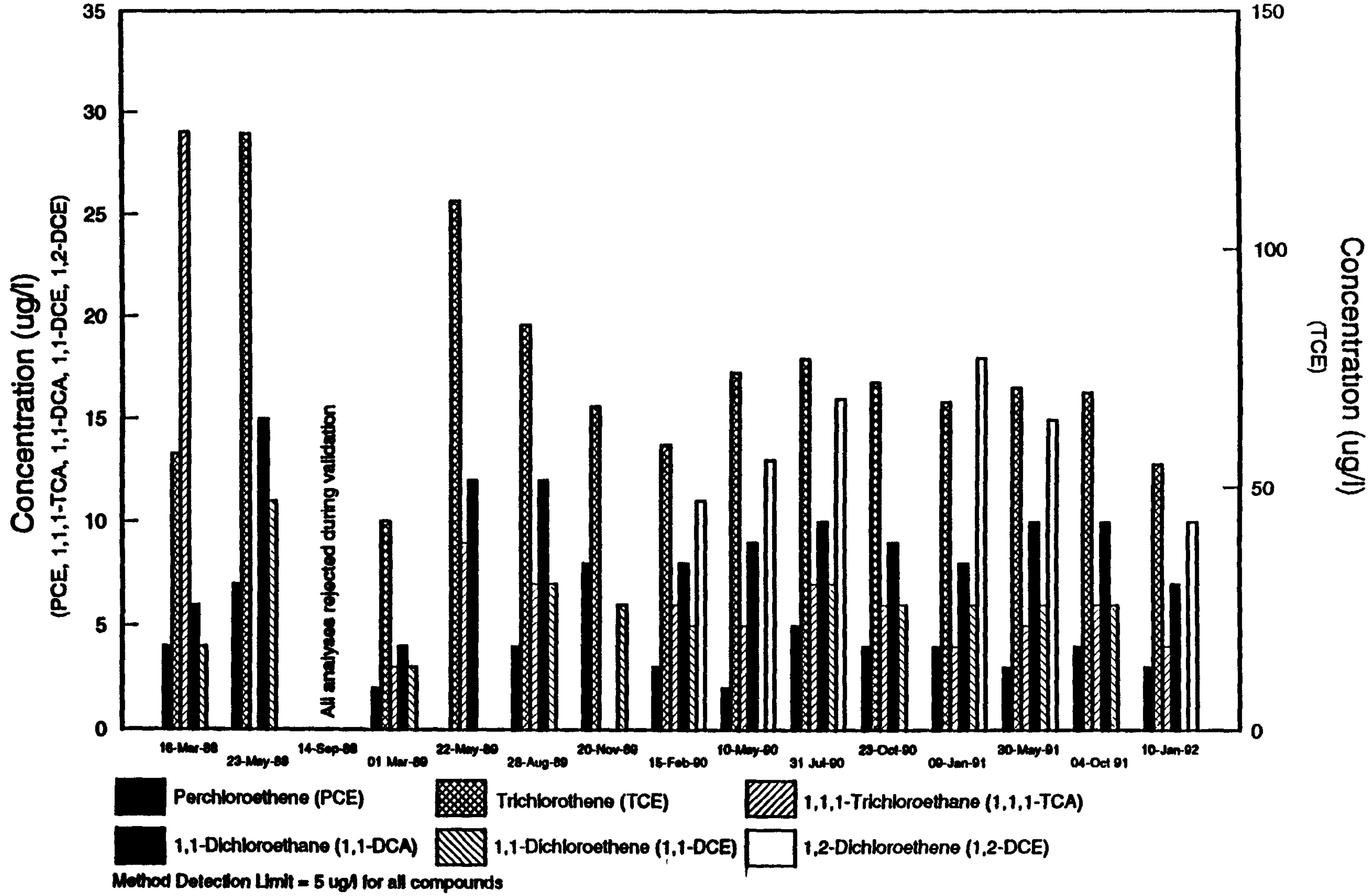

FIGURE 2-30

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER SAMPLES FROM WELL 5687

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN
U S DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden Colorado

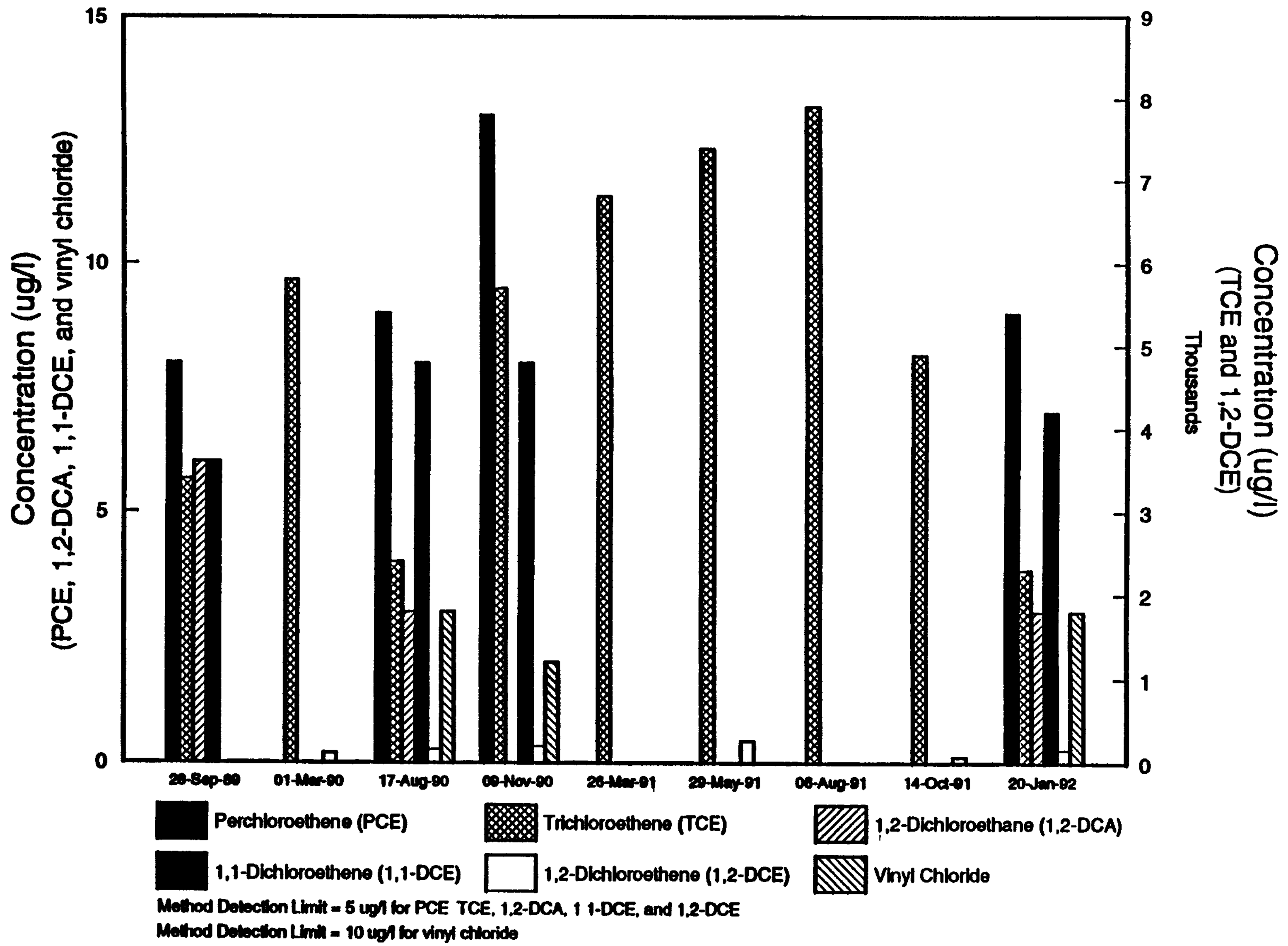

FIGURE 2-31

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER SAMPLES FROM WELL P210189

OPERABLE UNIT NO 8
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Rocky Flats Plant, Golden Colorado

234/266

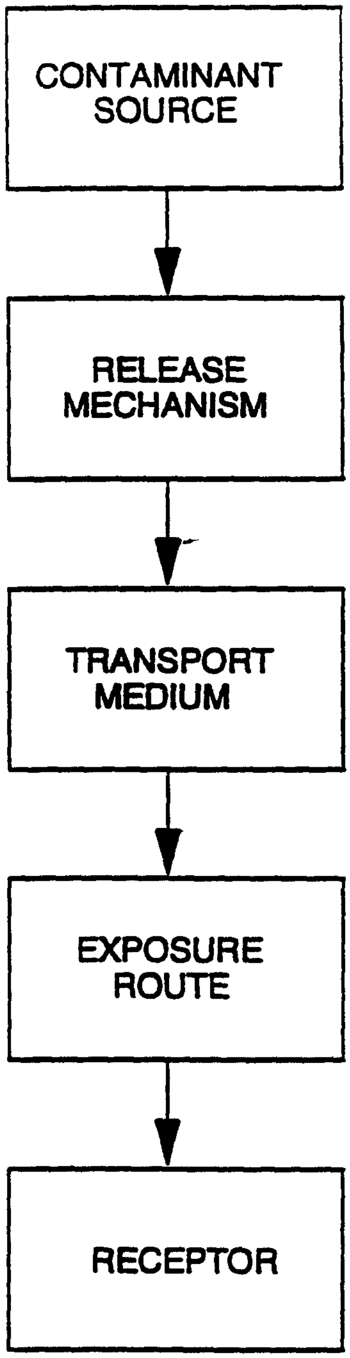

FIGURE 2-33
COMPONENTS OF A COMPLETED EXPOSURE PATHWAY

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Rocky Flats Plant, Golden, Colorado

Appr. IAH Date 10/28/93

Approved B ______________ Date 10/31/92

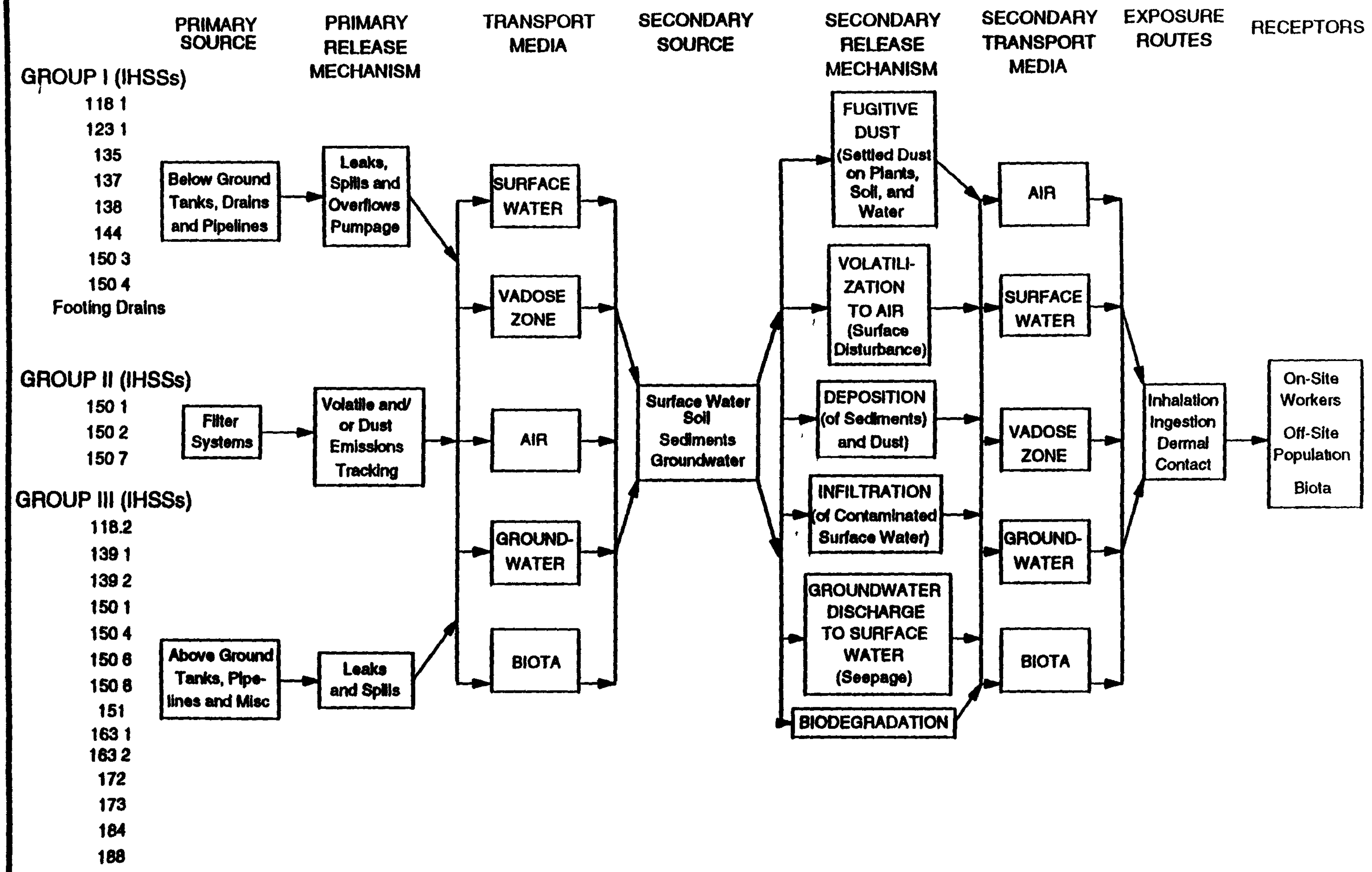

FIGURE 2-34
CONCEPTUAL MODEL FLOW CHART

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235/266

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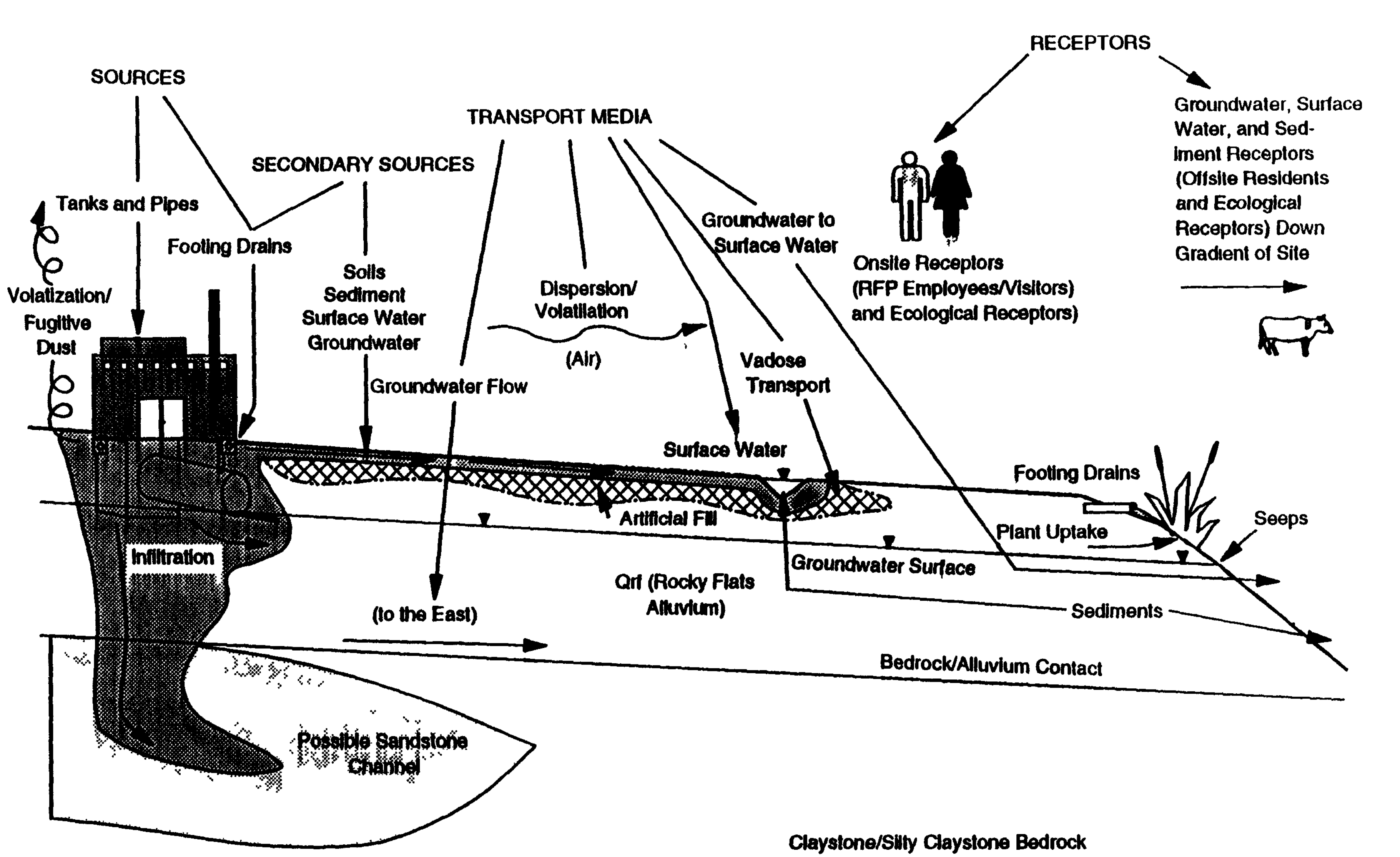

(NOT TO SCALE)

FIGURE 2-35
GROUP I - CONCEPTUAL MODEL

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236/266

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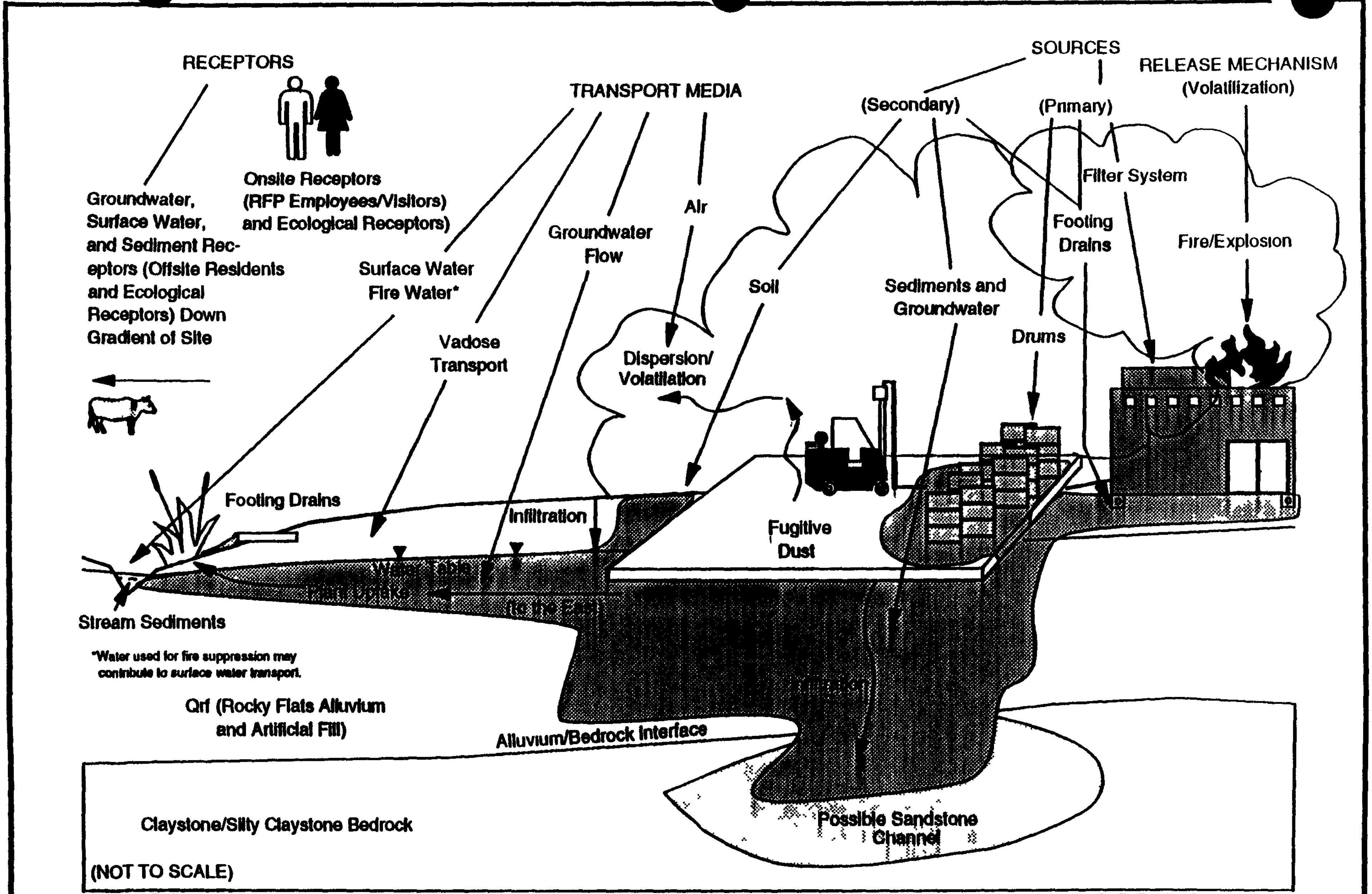

FIGURE 2-36
GROUP II - CONCEPTUAL MODEL

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237/266

238/266

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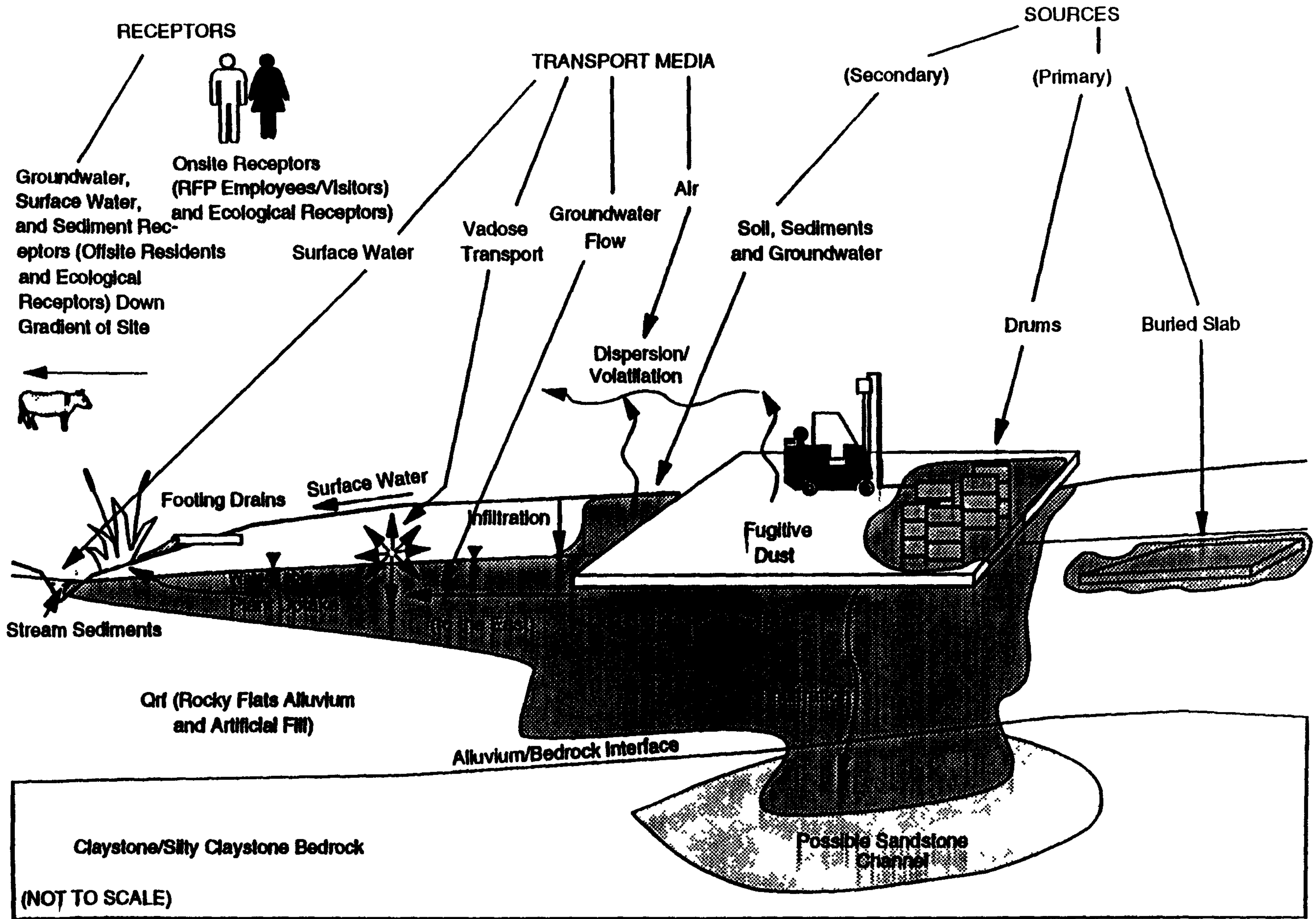

FIGURE 2-37
GROUP III - CONCEPTUAL MODEL

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INFORMATION ONLY

Approved By

6/28/94 — Manager, Remediation Programs

6/23/94 — RFI Project Manager

3.0 ROCKY FLATS PLANT CHEMICAL SPECIFIC BENCHMARKS

Tables 3.1 through 3.4 provide a preliminary identification of potential Chemical-specific Benchmarks for groundwater and surface water at RFP Chemical-specific Benchmarks for soil have not been developed at this time EPA analytical methods and detection limits have been specified for soil analyses to obtain data of the highest quality with the lowest possible detection limits The Benchmarks included in this section were developed for the entire Rocky Flats Plant site and are not specific to OU8 Site specific ARARs will be developed as the initial step of the Corrective Measures Study for OU8 As validated data become available from RFI/RI investigations obtained pursuant to this Work Plan, the Benchmarks will be reevaluated in accordance with Chapter Three, Part 15 of the IAG (DOE, 1991) The site-wide Benchmarks included in this work plan are not intended for use in establishing cleanup goals, however, they will be used to establish RFI/RI analytical detection limits Cleanup criteria for OU8 will be site specific and shall be based on results of an environmental and human-based Risk Assessment

The Colorado Department of Health and the Environmental Protection Agency have advanced the concept of establishing ARARs on a site-wide (all Rocky Flats OUs) basis The DOE, on the other hand, believes that ARARs should be established on a site- (OU-) specific basis so that OU-specific knowledge and individual site characteristics can be considered in the process. This OU by OU approach is consistent with the NCP and EPA guidance. In order to meet the agencies needs, a list of Chemical Specific Benchmarks has been developed This is a master list of possible contaminants which may be present across the entire Rocky Flats Plant site This list provides identification of the compound, a listing of federal and state regulations that may apply to that compound, the Practical Quantitation Limit (PQL), which is the level at which the amount of analyte can be reliably measured, and the method of analysis which the PQL is based upon

In some cases the Minimum Detection Limit (MDL) is listed instead of the PQL The MDL is the lowest concentration at which the analyte can be detected but not necessarily measured.

Rocky Flats has been following the historical CERCLA/RCRA procedure of utilizing transitional EPA Contract Laboratory Program (CLP) Routine Analytical Service (RAS) protocol for Phase 1 study This methodology is described as a managed approach whereby:

1 The benchmark table will be used in the Phase I investigations in conjunction with the CLP-RAS analytical methods to scope the initial RFI/RI investigation[1].

2. Following receipt and analysis of all field investigation data, a weight-of-evidence evaluation will be used to assess the adequacy of the analytical program relative to study objectives[2].

---

[1] CLP-RAS methods are the workhorses of the hazardous waste industry Collectively, a full CLP-RAS suite includes 126 organic (and a specified number of Tentatively Identified Compounds (TICs), and 25 inorganic compounds Standard radiochemistry analysis includes 12 radioisotopes These broad-brush methods provide a reasonable trade-off between specificity (the number of compounds detectable) and sensitivity (detection limit) It is standard practice to utilize CLP-RAS methods in the first phase of a study where contaminant identification is emphasized more than quantitation Following identification of contaminants of concern, follow up sampling and analysis with a more sensitive method can be performed if quantitation is still an issue This step-wise methodology was used in the OU1 881 Hillside Phase III study and the OU2 903 Pad and East Trenches, Phase II study

[2] The weight-of-evidence evaluation will consider factors such as the number of detections of specific chemicals, observed concentration range, fate and transport characteristics, their occurrence-distribution and concentration relative to overall site risk, as well as likely ARAR determination.

3 If the weight-of-evidence evaluation suggests that a particular compound or group of compounds warrant further assessment at lower quantitation limits, then follow up sampling and analysis with Special Analytical Services (SAS) will be performed as necessary

Site-wide Benchmarks represented in Table 3.1 through 3.4 were developed from the following sources:

- CDH, Water Quality Control Commission (WQCC), groundwater standards;
- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs), surface water and groundwater;
- Clean Water Act (CWA), Ambient Water Quality Criteria (AWQC), potentially applicable to surface water and groundwater,
- RCRA, Subpart F, Groundwater Concentration Limits (40 CFR 264.94), groundwater standards, and
- CDH, WQCC proposed statewide and classified groundwater area standards.

In instances where Benchmarks have not been proposed for a particular chemical or for a particular type of investigative method, EG&G's General Radiochemistry and Routine Analytical Services Protocol (GRRASP) or other appropriate laboratory procedures will be considered as the practical quantitation limits and will be applied

TABLE 3.1

BENCHMARKS

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

		PQL/MDL			FEDERAL STANDARDS					STATE STANDARDS							
Parameter	Type	RFP	CDH	Method	SDWA [illegible]	SDWA [illegible]	SDWA [illegible]	SDWA [illegible]	RCRA [illegible]	Basic Std. Table A	Table 1	Table 2	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Bicarbonate	A	10 000		E310 1													
Carbonate	A	10,000		E310 1													
Chloride	A	5,000		E325	250 000 *							250 000					
Chlorine	A	1 000		E4500													
Fluoride	A	5 000		E340	4,000- 2 000*		4,000				4,000		2 000				
N as Nitrate	A	5 000		E353 1	10,000			10,000			10,000						
N as Nitrate+Nitrite	A	5 000		E353 1		10,000		10,000					100 000				
N as Nitrite	A	5 000		E354.1		1 000		1,000			1 000		10,000				
Sulfate	A	5 000		E375 4	250 000*							250 000					
Sulfide	A																
Coliform (total)	B	1		SM9221C	1/100 ml						1/100 ml						
Ammonia as N	C	5 000		E350													
Dioxin	D		0 01(9)	8						0 00000022					0 000000013		
Sulfur	E	100,000		E600													
Dissolved Oxygen	FP	500		SM4500													
pH	FP	0 1		E150.1	6.5-8 5 *							6.5-8.5	6 5-8 5				
Specific Conductance	FP	1		E120 1													
Temperature	FP																
Boron		5 000		E6010									750				
Total Dissolved Solids		10,000		E160.1	500,000*									400 000 (1)			
Aluminum	M	200		CT		50 to 200*							5,000				
Antimony	M	60		CT													
Arsenic	M	10		CT	50				50	50			100				
Arsenic III	M																
Arsenic V	M																
Barium	M	200		CT	1,000	2 000 (e)		2,000 (e)	1,000	1,000							
Beryllium	M	5		CT									100				
Cadmium	M	5		CT	10	5		5	10	10			10				
Calcium	M	5 000		CT													
Cesium	M	1 000		NC													
Chromium	M	10		CT	50	100		100	50	50			100				
Chromium III	M	5		SW8467196													
Chromium VI	M	10		E218.5													
Cobalt	M	50		CT									50				
Copper	M	25		CT	1,000 *			1 300 (f)				1 000	200				
Cyanide	M	10		CT						200							
Iron	M	100		CT	300 *							300	5 000				
Lead	M	5		CT	50			0 (f)	50	50			100				
Lithium	M	100		NC									2,500				
Magnesium	M	5000		CT													

5/30

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

Parameter	Type (3)	PQL/MDL RFP	PQL/MDL CDH	Method (4)	FEDERAL STANDARDS: SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA [illegible]	SDWA [illegible]	RCRA [illegible]	STATE STANDARDS: Statewide Table A	CDH CWQCC Groundwater Quality Standards, Site-Specific: Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 [illegible]	Table 6 Radionuclides: Woman Creek	Table 6 Radionuclides: Walnut Creek
Manganese	M	15		CT	50 *							50	200				
Mercury	M	0 2		CT	2	2		2	2		2		10				
Molybdenum	M	200		NC													
Nickel	M	40		CT									200				
Potassium	M	5000		CT													
Selenium	M	5		CT	10	50		50	10		10		20				
Silver	M	10		CT	50	100 *			50		50						
Sodium	M	5000		CT													
Strontium	M	200		NC													
Thallium	M	10		CT													
Tin	M	200		NC													
Titanium	M	10		B6010													
Tungsten	M	10		B6010													
Vanadium	M	50		CT									100				
Zinc	M	20		CT	5,000 *							5 000	2,000				
2 4 5 TP Silvex	P		0 5	[illegible]	10	50		50	10	50							
2 4-Dichlorophenoxyacetic Acid	P		1	[illegible]	100	70		70	100	70							
(2 4-D)	P																
Acrolein	P		10														
Aldicarb	P		10			3 (e)		1 (e)		10							
Aldrin	P	0 05	0 1	CP						0.002					0 000074		
Bromacil	P																
Carbofuran	P			[illegible]		40		40		36							
Chloranil	P																
Chlordane (Alpha)	P	0 5	1	CP		2		0		0 03					0 00046		
Chlordane (Gamma)	P	0 5	1	CP		2		0		0 03					0 00046		
Chlorpyrifos	P			B619													
DDT	P	0 1	0 1	CP						0 1					0 000024		
DDT Metabolite (DDD)	P	0 1		CP													
DDT Metabolite (DDE)	P	0 1	0 1	CP						0 1							
Demeton	P																
Diazinon	P																
Dieldrin	P	0 1	0.1	CP						0 002					0 000071		
Endosulfan I	P	0.05		CP													
Endosulfan II	P	0 1		CP													
Endosulfan sulfate	P	0 1		CP													
Endrin	P	0 1	0 1	CP	0.2				0.2	0.2							
Endrin Aldehyde	P		0 1							0 2							
Endrin Ketone	P	0 1		CP													
Guthion	P																
Heptachlor	P	0 05	0 05	CP		0 4		0		0 008					0 00028		
Heptachlor Epoxide	P	0 05	0 05	CP		0 2		0		0 09							

6/30

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (4)							
										Statewide	Site Specific (4)						
		PQL MDL			SDWA Maximum Contaminant Level (4)	SDWA Maximum Contaminant Level (4)	SDWA Maximum Contaminant Level [illegible]	SDWA Maximum Contaminant Level [illegible]	RCRA Subpart F [illegible]	Table 1/A (2)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 8 Radionuclides	
Parameter	Type (3)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Hexachlorocyclohexane, Alpha	P	0 05	0 05	CP						0 006					0 0092		
Hexachlorocyclohexane, Beta	P	0 05	0 1(9)	CP											0 0163		
Hexachlorocyclohexane, BHC	P		0 05														
Hexachlorocyclohexane, Delta	P	0 05		CP													
Hexachlorocyclohexane, Tech	P		0 5(9)	[illegible]											0 0123		
Hexachlorocyclohexane, Lindane	P	0 05	0 05	CP	4	0 2		0 2	4 0	0 2					0 0186		
Malathion	P																
Methoxychlor	P	0 5	0 5	CP	100	40		40	100	40	100						
Mirex	P																
Parathion	P																
PCBs	P	0 5	1	CP		0 5		0		0 005					0 000079		
Simazine	P			[illegible]											4		
Toxaphene	P	1	5	CP		3		0	5 0	0 03	5						
Vaponite 2	P																
Aroclor 1016	PP	0 5		CP													
Aroclor 1221	PP	0 5		CP													
Aroclor 1232	PP	0 5		CP													
Aroclor 1242	PP	0 5		CP													
Aroclor 1248	PP	0 5		CP													
Aroclor 1254	PP	1		CP													
Aroclor 1260	PP	1		CP													
Atrazine	PP		3 (9)	[illegible]		3		3							3		
Americium (pCi/l)	R															0 05	0 05
Americium 241 (pCi/l)	R	0 01															
Cesium 134 (pCi/l)	R	1								80 (2)						80	80
Cesium 137 (pCi/l)	R	1															
Gross Alpha (pCi/l)	R	2			15 (8)						15(8)					7	11
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)						4 mrem/yr					5	19
Plutonium (pCi/l)	R															0 05	0 05
Plutonium 238+239+240 (pCi/l)	R	0 01								15 (2)							
Radium 226+228 (pCi/l)	R	0 5/1 0 (4)			5					5 (2)							
Strontium 89+90 (pCi/l)	R	1															
Strontium 90 (pCi/l)	R				8 (3)					8 (2)						8	8
Thorium 230+232 (pCi/l)	R									60 (2)							
Tritium (pCi/l)	R				20,000 (3)					20 000 (2)						500	500
Uranium 233+234 (pCi/l)	R																
Uranium 235 (pCi/l)	R	0 6															
Uranium 238 (pCi/l)	R	0 6															
Uranium (Total) (pCi/l)	R															5	10
1 2,4 5 Tetrachlorobenzene	SV		10	[illegible]						2							
1 2 4-Trichlorobenzene	SV	10		CS													

7/30

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										Statewide	CDH WQCC Groundwater Quality Standards (d)						
Parameter	Type (b)	PQL RFI	PQL CDH	Method (c)	SDWA Maximum Contaminant Level	SDWA Maximum Contaminant Level Goal	SDWA Proposed	SDWA Proposed	RCRA	Table A	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Walnut Creek	Woman Creek
1 2 Dichlorobenzene (Ortho)	SV	10	1	CS		600		600		620							
1 2 Diphenylhydrazine	SV			b						0.05							
1 3 Dichlorobenzene (Meta)	SV	10	1	CS						620							
1 4 Dichlorobenzene (Para)	SV	10	1	CS	75		75			75							
2 4 5 Trichlorophenol	SV	50		CS						700							
2 4 6-Trichlorophenol	SV	10	50	CS						2							
2,4-Dichlorophenol	SV	10	50	CS						21					1 2		
2 4 Dimethylphenol	SV	10		CS													
2 4 Dinitrophenol	SV	50	50	CS						14							
2 4-Dinitrotoluene	SV	10		CS													
2 6-Dinitrotoluene	SV	10		CS													
2 Chloronaphthalene	SV	10		CS													
2 Chlorophenol	SV	10		CS													
2 Methylnaphthalene	SV	10		CS													
2 Methylphenol	SV	10		CS													
2 Nitroaniline	SV	50		CS													
2 Nitrophenol	SV	10		CS													
3 3 Dichlorobenzidine	SV	20		CS													
3 Nitroaniline	SV	50		CS													
4 6-Dinitro-2-methylphenol	SV	50		CS													
4-Bromophenyl Phenylether	SV	10		CS													
4-Chloroaniline	SV	10		CS													
4-Chlorophenyl Phenyl Ether	SV	10		CS													
4-Chloro-3 methylphenol	SV	10		CS													
4-Methylphenol	SV	10		CS													
4-Nitroaniline	SV	50		CS													
4-Nitrophenol	SV	50		CS													
Acenaphthene	SV	10		CS													
Anthracene	SV	10		CS													
Benzidine	SV		10	4						0 0002	0 1				0 00012		
Benzoic Acid	SV	50		CS													
Benzo(a)anthracene	SV	10		CS													
Benzo(a)pyrene	SV	10		CS													
Benzo(b)fluoranthene	SV	10		CS													
Benzo(g,h,i)perylene	SV	10		CS													
Benzo(k)fluoranthene	SV	10		CS													
Benzyl Alcohol	SV	10		CS													
bis(2 Chloroethoxy)methane	SV	10		CS													
bis(2 Chloroethyl)ether	SV	10		CS						0 03					0 0000037		
bis(2 Chloroisopropyl)ether	SV	10		CS													
bis(2 Ethylhexyl)phthalate	SV	10		CS													
Butadiene	SV																
Butylbenzylphthalate	SV	10		CS													

8/30

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
		PQL			SDWA	SDWA	SDWA	SDWA	RCRA	CDH-WQCC Groundwater Quality Standards							
Parameter	Type (1)	EPA RFP	CDH	Method						Table A	Table 1	Table 2	Table 3	Table 4 TDS	Table 5 Organic	Table 6 Radionuclides: Woman Creek	Walnut Creek
Chlorinated Ethers	SV																
Chlorinated Napthalenes	SV																
Chloroalkylethers	SV	10		CS													
Chlorophenol	SV																
Chrysene	SV	10		CS													
Dibenzofuran	SV	10		CS													
Dibenz(a,h)anthracene	SV	10		CS													
Dichlorobenzenes	SV																
Dichlorobenzidine	SV	20	10(9)	CS											0 01		
Diethylphthalate	SV	10		CS													
Dimethylphthalate	SV	10		CS													
Di n-butylphthalate	SV	10		CS													
Di n octylphthalate	SV	10		CS													
Ethylene Glycol	SV			d						7 000							
Fluoranthene	SV	10		CS													
Fluorene	SV	10		CS													
Formaldehyde	SV																
Haloethers	SV																
Hexachlorobenzene	SV	10	10	CS						6					0 00072		
Hexachlorobutadiene	SV	10	10	CS						1					0 45		
Hexachlorocyclopentadiene	SV	10		CS						49							
Hexachloroethane	SV	10		CS											1 9		
Hydrazine	SV																
Indeno(1,2,3 cd)pyrene	SV	10		CS													
Isophorone	SV	10	10	CS						1 050							
Naphthalene	SV	10		CS													
Nitrobenzene	SV	10	10	CS						3.5							
Nitrophenols	SV																
Nitrosamines	SV		10														
Nitrosodibutylamine	SV			b											0 0064		
Nitrosodiethylamine	SV		10	b											0 0008		
Nitrosodimethylamine	SV		10	b											0 0014		
Nitrosopyrrolidine	SV		10	b											0 016		
N Nitrosodiphenylamine	SV	10	10(9)	CSb											4 9		
N Nitroso-di-n-dipropylamine	SV	10		CSb													
Pentachlorinated Ethanes	SV			b													
Pentachlorobenzene	SV		10	b						6 (7)							
Pentachlorophenol	SV	50	50	CS		1 (c)		0 (e)		200							
Phenanthrene	SV	10		CS													
Phenol	SV	10		CS													
Phthalate Esters	SV																
Polynuclear Aromatic Hydrocarbons	SV		1 (9)	b											0 0028		
Vinyl Chloride	SV	10	2	CV	2		0			2							

9/30

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

Parameter	Type (f)	PQL (ug/l) RFP	PQL (ug/l) CDH	Method (g)	FEDERAL STANDARDS SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal (b)	RCRA Maximum Limit (e)	STATE STANDARDS Statewide Table A	CDH WQCC Table 2	Table 3	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
1 1 1 Trichloroethane	V	5	1	CV	200		200			200							
1 1 2 2 Tetrachloroethane	V	5	1 (9)	CV											0 17		
1 1 2 Trichloroethane	V	5	1	CV						3					0 6		
1 1 Dichloroethane	V	5		CV													
1 1 Dichloroethene	V	5	1	CV	7		7			7							
1 2 Dichloroethane	V	5	1	CV	5		0			0 4							
1 2 Dichloroethene (cis)	V		1	a		70		70		70							
1 2 Dichloroethene (total)	V	5		CV													
1 2 Dichloroethene (trans)	V		1	a		100		100		100							
1 2 Dichloropropane	V	5	1	CV		5		0		0 56							
1 3 Dichloropropene (cis)	V	5		CV													
1 3 Dichloropropene (trans)	V	5		CV													
2 Butanone	V	10		CV													
2 Hexanone	V	10		CV													
4-Methyl-2 pentanone	V	10		CV													
Acetone	V	10		CV													
Acrylonitrile	V		15(9)	c											0 058		
Benzene	V	5	1	CV	5		0			1							
Bromodichloromethane	V	5	1	CV						0 3							
Bromoform	V	5	1	CV						4							
Bromomethane	V	10		CV													
Carbon Disulfide	V	5		CV													
Carbon Tetrachloride	V	5	1	CV	5		0			0 3							
Chlorinated Benzenes	V	10		CV/CS													
Chlorobenzene	V	5	1	CV/CS		100		100		100							
Chloroethane	V	10		CV													
Chloroform	V	5	1	CV	Tot THM <100**					5					0 19		
Chloromethane	V	10		CV													
Dibromochloromethane	V	5	1	CV						14							
Dichloroethanes	V																
Ethyl Benzene	V	5	1	CV		700		700		680							
Ethylene Dibromide	V			d		0 05		0		0.0004							
Ethylene Oxide	V																
Halomethanes	V		1 (9)		100					100					0 19		
Methylene Chloride	V	5		CV													
Pyrene	V	10		CS													
Styrene	V	5		CV		100		100									
Tetrachloroethanes	V	5		CV													
Tetrachloroethene	V	5	1	CV		5		0		5					0.8		
Toluene	V	5	1	CV		1 000		1,000		1,000							
Trichloroethanes	V	5		CV													

10/30

TABLE 3 1 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

Parameter	Type (1)	PQL (ug/l) RFP	PQL (ug/l) CDH	Method (4)	FEDERAL STANDARDS: SDWA Maximum Contaminant Level (4)	SDWA Maximum Contaminant Level (4)	SDWA [illegible]	SDWA [illegible]	RCRA [illegible]	STATE STANDARDS: Statewide Table A [illegible]	CDH CWQCC [illegible]: Table 1 [illegible]	Table 2 [illegible]	Table 3 [illegible]	Table 4 [illegible]	Table 5 [illegible]	Table 6 Radionuclides: Woman Creek	Table 6 Radionuclides: Walnut Creek
Trichloroethene	V	5	1	CV	5		0			5							
Vinyl Acetate	V	10		CV													
Xylenes (total)	V	5		CV		10,000		10,000									

EXPLANATION OF TABLE

* = secondary maximum contaminant level

** = total trihalomethanes chloroform bromoform, bromodichloromethane dibromochloromethane

CDH = Colorado Department of Health
CLP = Contract Laboratory Program
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Limit
RCRA = Resource Conservation and Recovery Act
RFP = Rocky Flats Plant
SDWA = Safe Drinking Water Act
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
CWQCC = Colorado Water Quality Control Commission

11/30

TABLE E 3 2 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (1)	PQL MDL RFP	PQL CDH	Method (2)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels	SDWA [illegible]	SDWA Maximum Contaminant [illegible]	CWA AWQC for Protection of Aquatic Life Acute Value	CWA AWQC for Protection of Aquatic Life Chronic Value	CWA AWQC for Protection of Human Health Water and Fish Ingestion	CWA AWQC for Protection of Human Health Fish Consumption Only	NRC Effluent Standards Water [illegible]
Bicarbonate	A	10,000		E310.1									
Carbonate	A	10,000		E310.1									
Chloride	A	5 000		E325	250,000*				860 000(e)	230 000(e)			
Chlorine	A	1,000		E4500					19	11			
Flouride	A	5 000		E340	4,000- 2 000*		4,000					4 000	
N as Nitrate	A	5 000		E353 1	10 000			10,000			10 000		
N as Nitrate+Nitrite	A	5 000		E353 1		10 000		10,000					
N as Nitrite	A	5,000		E354 1		1 000		1,000					
Sulfate	A	5 000		E375 4	250 000*								
Sulfide	A												
Coliform (Fecal)	B	1		SM9221C	1/100 ml								
Ammonia as N	C	5 000		E350					Criteria are pH and temperature dependent see criteria document				
Dioxin	D			1					0.01	0 00001	0 000000013	0 000000014	
Sulfur	E	100 000		E600									
Dissolved Oxygen	FP	500		SM4500					5 000				
pH	FP	0 1		E150 1	6 5 8.5 *					6 5 9			
Specific Conductance	FP	1		E120.1									
Temperature	FP								SS	SS			
Boron	I	5 000		E6010									
Total Dissolved Solids	I	10,000		E160 1	500,000*				SS	SS	250 000		
Aluminum	M	200		CT		50 to 200*			750	87			
Antimony	M	60		CT					9,000	1 600	146	45 000	
Arsenic	M	10		CT	50						0 0022	0 0175	
Arsenic III	M								360	190			
Arsenic V	M								850	48			
Barium	M	200		CT	1 000	2,000 (f)		2,000 (f)			1,000		
Beryllium	M	5		CT					130	5 3	0068**	117**	
Cadmium	M	5		CT	10	5		5	3 9 (3)	1 1 (3)	10		
Calcium	M	5,000		CT									
Cesium	M	1,000		NC									
Chromium	M	10		CT	50	100		100					
Chromium III	M	5		SW8467196					1 700	210	170 000	3 433 000	
Chromium VI	M	10		E218.5					16	11	50		
Cobalt	M	50		CT									
Copper	M	25		CT	1 000*			1 300 (g)	18 (3)	12 (3)			
Cyanide	M	10		CT					22	5.2	200		
Iron	M	100		CT	300 *					1 000	300		
Lead	M	5		CT	50			0 (g)	82 (3)	3 2 (3)	50		
Lithium	M	100		NC									
Magnesium	M	5000		CT									
Manganese	M	15		CT	50 *						50	100	
Mercury	M	0.2		CT	2	2		2	2 4	0 012	0 144	0 146	
Molybdenum	M	200		NC									
Nickel	M	40		CT					1,400 (3)	160 (3)	13 4	100	
Potassium	M	5000		CT									
Selenium	M	5		CT	10	50		50	20 (d)	5 (d)	10		
Silver	M	10		CT	50	100 *			4 1 (3)	0 12	50		
Sodium	M	5000		CT									
Strontium	M	200		NC									
Thallium	M	10		CT					1,400 (1)	40 (1)	13	48	
Tin	M	200		NC									

TABLE E 3 2 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (5)	SDWA Maximum Contaminant Levels (9)	SDWA Maximum Contaminant Level Goals	SDWA Maximum Contaminant Level Goals	CWA AWQC for Protection of Aquatic Life (4) Acute Value	CWA AWQC for Protection of Aquatic Life (4) Chronic Value	CWA AWQC for Protection of Human Health (4) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (4) Fish Consumption Only	NRC Effluent Standards Water PCFL
Titanium	M	10		B6010									
Tungsten	M	10		B6010									
Vanadium	M	50		CT									
Zinc	M	20		CT	5 000 *				120 (3)	110 (3)			
2 4 5 TP Silvex	P		0 5	4	10	50		50					
2 4-Dichlorophenoxyacetic Acid (2 4-D)	P		1	4	100	70		70					
Acrolein	P		10						68(1)	21(1)	320	780	
Aldicarb	P		10			3 (f)		1 (f)					
Aldrin	P	0 05	0 1	CP					3 0		0 000074	0 000079	
Bromacil	P												
Carbofuran	P			4		40		40					
Chloranil													
Chlordane (Alpha)	P	0 5	1	CP		2		0	2 4	0 0043	0 00046	0 00048	
Chlordane (Gamma)	P	0.5	1	CP		2		0	2 4	0 0043	0 00046	0 00048	
Chlorpyrifos	P		0 1	8619					0 063	0 041			
DDT	P	0 1	0 1	CP					1 1	0 0011	0 000024	0 000024	
DDT metabolite (DDD)	P	0.1	0.1	CP					0 06				
DDT metabolite (DDE)	P	0 1	0 1	CP					1,050				
Demeton	P		1							0 1			
Diazinon	P												
Dieldrin	P	0 1	0 1	CP					2.5	0 0019	0 00007	0 000076	
Endosulfan I	P	0.05	0 1	CP					0 22	0 056	74	159	
Endosulfan II	P	0 1	0 1	CP									
Endosulfan Sulfate	P	0 1	0 1	CP									
Endrin	P	0 1	0 1	CP	0 2				0 18	0 0023	1		
Endrin Aldehyde	P		0 1										
Endrin Ketone	P	0 1		CP									
Guthion	P		1 5							0 01			
Heptachlor	P	0 05	0 05	CP		0 4		0	0.52	0 0038	0 00028	0 00029	
Heptachlor Epoxide	P	0.05	0.05	CP		0 2		0					
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP							0 0092	0 031	
Hexachlorocyclohexane, Beta	P	0.05	0 05	CP							0 0163	0 0547	
Hexachlorocyclohexane, BHC	P	0 05	0 05										
Hexachlorocyclohexane, Delta	P	0.05		CP									
Hexachlorocyclohexane, Technical	P		0 2	7							0 0123	0 0414	
Hexachlorocyclohexane, (Lindane) Gama	P	0 05	0 05	CP	4	0 2		0.2	2.0	0 08			
Malathion	P		0 2							0 01			
Methoxychlor	P	0 5	0 5	CP	100	40		40		0 03	100		
Mirex	P		0 1							0.001			
Parathion	P								0.065	0 013			
PCBs	P	0 5	1	CP		0 5		0	2.0	0 014	0 000079**	0 000079**	
Simazine	P			a									
Toxaphene	P	1	5	CP		3		0	0 73	0 0002	0 00071**	0 00073**	
Vaponite 2	P												
Aroclor 1016	PP	0 5		CP									
Aroclor 1221	PP	0 5		CP									
Aroclor 1232	PP	0 5		CP									
Aroclor 1242	PP	0.5		CP									
Aroclor 1248	PP	0.5		CP									
Aroclor 1254	PP	1		CP									
Aroclor 1260	PP	1		CP									
Atrazine	PP			a		3		3					

13/30

TABLE 3 2 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (2)	PQL MDL/RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (c)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (c)	CWA AWQC for Protection of Aquatic Life (e) Acute Value	CWA AWQC for Protection of Aquatic Life (e) Chronic Value	CWA AWQC for Protection of Human Health (e) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (e) Fish Consumption Only	NRC Effluent Standards Water (pCi/l)
Americium (pCi/l)	R												
Americium 241 (pCi/l)	R	0 01											20
Cesium 134 (pCi/l)	R	1											900
Cesium 137 (pCi/l)	R	1											1000
Gross Alpha (pCi/l)	R	2			15 (10)							15	
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)								
Plutonium (pCi/l)	R												
Plutonium 238+239+240 (pCi/l)	R	0 01											20
Radium 226+228 (pCi/l)	R	0 5/0 1 (9)			5							5	60
Strontium 89+90 (pCi/l)	R	1											500
Strontium 90 (pCi/l)	R				8 (6)							8	500
Thorium 230+232 (pCi/l)	R												30
Tritium (pCi/l)	R				20 000 (6)								1000000
Uranium 233+234 (pCi/l)	R												300
Uranium 235 (pCi/l)	R	0 6											300
Uranium 238 (pCi/l)	R	0.6											300
Uranium (total) (pCi/l)	R												
1 2 4 5 Tetrachlorobenzene	SV		10	b							38	48	
1 2 4-Trichlorobenzene	SV	10		CS									
1 2 Dichlorobenzene (Ortho)	SV	10	10	CS		600		600					
1 2 Diphenylhydrazine	SV			b					270 (1)				
1 3 Dichlorobenzene (Meta)	SV	10	1	CS									
1 4-Dichlorobenzene (Para)	SV	10	1	CS	75		75						
2 4 5-Trichlorophenol	SV	50		CS							2 800		
2 4 6-Trichlorophenol	SV	10	50	CS						970 (1)	1 2 **	3 6 **	
2 4-Dichlorophenol	SV	10	50	CS					2 020 (1)	365 (1)	3 090		
2 4-Dimethylphenol	SV	10	50	CS					2 120 (1)				
2 4-Dinitrophenol	SV	50	50	CS									
2 4-Dinitrotoluene	SV	10	10	CS							0 11 **	9 1 **	
2 6-Dinitrotoluene	SV	10	10	CS					330 (1)	230 (1)	70	14 300	
2 Chloronaphthalene	SV	10		CS									
2 Chlorophenol	SV	10	50	CS					4,360 (1)	2 000 (1)			
2 Methylnaphthalene	SV	10		CS									
2 Methylphenol	SV	10		CS									
2 Nitroaniline	SV	50		CS									
2 Nitrophenol	SV	10		CS									
3 3 Dichlorobenzidine	SV	20	10	CS							0 01	0 02	
3 Nitroaniline	SV	50		CS									
4 6-Dinitro-2-methylphenol	SV	50	50	CS									
4 Bromophenyl Phenylether	SV	10		CS									
4-Chloroaniline	SV	10		CS									
4 Chlorophenyl Phenyl Ether	SV	10		CS									
4-Chloro-3-methylphenol	SV	10	50	CS					30 (1)				
4-Methylphenol	SV	10		CS									
4-Nitroaniline	SV	50		CS									
4-Nitrophenol	SV	50		CS					230 (1)	150 (1)			
Acenaphthene	SV	10	10	CS					1 700 (1)	520 (1)			
Anthracene	SV	10	1	CS									
Benzidine	SV		1	d					2,500		0 00012	0 00053	
Benzoic Acid	SV	50		CS									
Benzo(a)anthracene	SV	10	10	CS									

14/30

TABLE 3 2 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals [illegible]	SDWA Maximum Contaminant Level Goals [illegible]	CWA AWQC for Protection of Aquatic Life (s) Acute Value	CWA AWQC for Protection of Aquatic Life (s) Chronic Value	CWA AWQC for Protection of Human Health (s) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (s) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Benzo(a)pyrene	SV	10	10	CS									
Benzo(b)fluoranthene	SV	10	10	CS									
Benzo(g,h,i)perylene	SV	10	10	CS									
Benzo(k)fluoranthene	SV	10	10	CS									
Benzyl Alcohol	SV	10		CS									
bis(2 Chloroethoxy)methane	SV	10		CS									
bis(2 Chloroethyl)ether	SV	10	10	CS							0 03**	1 36 **	
bis(2 Chloroisopropyl)ether	SV	10	10	CS							34 7	4 360	
bis(2 Ethylhexyl)phthalate	SV	10	10	CS							15 000	50 000	
Butadiene	SV												
Butylbenzylphthalate	SV	10	10	CS									
Chlorinated Ethers	SV												
Chlorinated Napthalenes	SV								1,600 (1)				
Chloroalkylethers	SV	10		CS					238,000 (1)				
Chlorophenol	SV		50										
Chrysene	SV	10	10	CS									
Dibenzofuran	SV	10		CS									
Dibenz(a,h)anthracene	SV	10	10	CS									
Dichlorobenzenes	SV		1						1 120 (1)	763 (1)	400	2 600	
Dichlorobenzidine	SV	20	10	CS							0 01	0 02	
Diethylphthalate	SV	10	10	CS							350 000	1 800 000	
Dimethylphthalate	SV	10	10	CS							313,000	2 900 000	
Di-n butylphthalate	SV	10	10	CS									
Di n-octylphthalate	SV	10		CS									
Ethylene Glycol	SV			d									
Fluoranthene	SV	10	10	CS					3 980 (1)		42	54	
Fluorene	SV	10	10	CS									
Formaldehyde	SV												
Haloethers	SV								380 (1)	122 (1)			
Hexachlorobenzene	SV	10	10	CS							0 00072**	0 00074**	
Hexachlorobutadiene	SV	10	10	CS					90 (1)	9 3 (1)	0.45**	50 **	
Hexachlorocyclopentadiene	SV	10	10	CS					7 (1)	5 2 (1)	206		
Hexachloroethane	SV	10	10	CS					980 (1)	540 (1)	1 9	8 74	
Hydrazine	SV												
Indeno(1,2 3 cd)pyrene	SV	10	10	CS									
Isophorone	SV	10	10	CS					117 000 (1)		5 200	520 000	
Naphthalene	SV	10	10	CS					2,300 (1)	620 (1)			
Nitrobenzene	SV	10	10	CS					27,000 (1)		19 800		
Nitrophenols	SV								230 (1)	150 (1)			
Nitrosamines	SV								5,850 (1)				
Nitrosodibutylamine	SV		10	b							0 0064	0 587	
Nitrosodiethylamine	SV		10	b							0 0008	1.24	
Nitrosodimethylamine	SV		10	b							0 0014	16	
Nitrosopyrrolidine	SV		10	b							0 016	91 9	
N Nitrosodiphenylamine	SV	10	10	b							4 9 **	16 1 **	
N-Nitroso-di-n-dipropylamine	SV	10	10	b									
Pentachlorinated Ethanes	SV			b					7,240 (1)	1 100 (1)			
Pentachlorobenzene	SV		10	b							74	85	
Pentachlorophenol	SV	50	50	CS		1 (f)		0 (f)	20 (4)	13 (4)	1 010		
Phenanthrene	SV	10	10	CS									
Phenol	SV	10	50	CS					10,200 (1)	2,560 (1)	3 500		
Phthalate Esters	SV			e					940 (1)	3 (1)			
Polynuclear Aromatic Hydrocarbons	SV		10	b							0 0028**	0 0311**	

15/30

16/30

TABLE 3 2 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (?)	PQL MDL RFP	PQL CDH	Method (?)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/l
Vinyl Chloride	SV	10	2	CV	2		0				2 **	525 **	
1 1 1 Trichloroethane	V	5	1	CV	200		200				18,400	1 030 000	
1 1 2 2 Tetrachloroethane	V	5	1	CV						2 400	0 17**	10 7 **	
1 1 2 Trichloroethane	V	5	1	CV						9 400	0 6**	41 8 **	
1 1 Dichloroethane	V	5		CV									
1 1 Dichloroethene	V	5	1	CV	7		7						
1 2 Dichloroethane	V	5	1	CV	5		0		118 000	20 000	0 94**	243 **	
1 2 Dichloroethene (cis)	V		1	a		70		70					
1 2 Dichloroethene (total)	V	5		CV									
1 2 Dichloroethene (trans)	V	5	1	a		100		100					
1 2 Dichloropropane	V	5	1	CV		5		0	23 000	5 700			
1 3 Dichloropropene (cis)	V	5	1	CV					6,060	244 (1)	87	14 100	
1 3 Dichloropropene (trans)	V	5	1	CV					6,060	244 (1)	87	14 100	
2 Butanone	V	10		CV									
2 Hexanone	V	10		CV									
4-Methyl 2 pentanone	V	10		CV									
Acetone	V	10		CV									
Acrylonitrile	V		5	c					7,500	2 600	0 058	0 65	
Benzene	V	5	1	CV	5		0		5,300		0 66**	40 **	
Bromodichloromethane	V	5	1	CV									
Bromoform	V	5	1	CV									
Bromomethane	V	10	1	CV									
Carbon Disulfide	V	5		CV									
Carbon Tetrachloride	V	5	1	CV	5		0		35,200 (1)		0 4**	6 94 **	
Chlorinated Benzenes	V	10		CV/CS					250 (1)	50 (1)			
Chlorobenzene	V	5	1	CV/CS		100		100					
Chloroethane	V	10		CV									
Chloroform	V	5	1	CV	Tot THM<100 (2)				28 900 (1)	1,240 (1)	0 19 **	15 7 **	
Chloromethane	V	10	1	CV									
Dibromochloromethane	V	5	1	CV									
Dichloroethenes	V		1						11 600 (1)		0 033**	1 85 **	
Ethyl Benzene	V	5	1	CV		700		700	32,000 (1)		1 400	3 280	
Ethylene Dibromide	V			d		0.05		0					
Ethylene Oxide	V												
Halomethanes	V				100				11 000 (1)		0 19**	15 7 **	
Methylene Chloride	V	5	1	CV									
Pyrene	V	10	10	CS									
Styrene	V	5	1	CV		100		100					
Tetrachloroethanes	V	5	1	CV					9,320 (1)				
Tetrachloroethene	V	5	1	CV		5		0	5,280 (1)	840 (1)	0.80**	8 85 **	
Toluene	V	5	1	CV		1 000		1 000	17,500 (1)		14,300	424 000	
Trichloroethanes	V	5	1	CV					18,000 (1)				
Trichloroethene	V	5	1	CV	5		0		45,000 (1)	21 900 (1)	2.7**	80 7	
Vinyl Acetate	V	10		CV									
Xylenes (total)	V	5		CV		10,000		10,000					

TABLE 3 2 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL		Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA [illegible]	SDWA [illegible]	CWA AWQC for Protection of		CWA AWQC for Protection of		NRC Effluent Standards
		MDL RFP	CDH						Aquatic Life (c) Acute Value	Chronic Value	Human Health (c) Water and Fish Ingestion	Fish Consumption Only	Water pCi/L

EXPLANATION OF TABLE
* = secondary maximum contaminant level
** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10 5 risk level

AWQC	= Ambient Water Quality Criteria
CLP	= Contract Laboratory Program
CWA	= Clean Water Act
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
SDWA	= Safe Drinking Water Act
SS	= Species Specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis

(1) criteria not developed value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7 8 pH used)
(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr
(7) type abbreviations are: A=anion; B=bacteria; C=cation, D=dioxin; E=element; I=indicator FP=field parameter M=metal; P=pesticide; PP=pesticide/PCB
R=radionuclide SV=semi volatile V=volatile
(8) method abbreviations are: CT=CLP TAL, NC=non-CLP CV=CLP VOA, CS=CLP SEMI EP=EPA PEST CP=CLP PEST, E=EPA, a = detected as total in CV b = detected as TIC in CS
c = detected as TIC in CV d = not routinely monitored; e = monitored in discharge ponds; f = mixture individual isomers detected.
(9) MDL for radium 226 is 0 5; MDL for radium 228 is 1.0
(10) Value for gross alpha excludes uranium

(a) EPA National Primary and Secondary Drinking Water Regulations 40 CFR 141 and 40 CFR 143 (as of May 1990).
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141 142 and 143 Final Rule, effective July 30, 1992 (56 Federal Register 3526 1/30/1991).
(c) EPA Quality Criteria for Protection of Aquatic Life, 1986
(d) EPA National Ambient Water Quality Criteria for Selenium 1987
(e) EPA National Ambient Water Quality Criteria for Chloride 1988
(f) EPA National Primary and Secondary Drinking Water Regulations 40 CFR Parts 141 142 and 143 Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.
(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 12/7/91

17/30

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (1)	PQL RFP	PQL CDH	Method (2)	Statewide Standards (a): Human Health Carcinogenic: Water Supply	Statewide Standards (a): Human Health Carcinogenic: Water + Fish	Statewide Standards (a): Aquatic Life: Acute Value	Statewide Standards (a): Aquatic Life: Chronic Value	Statewide Standards (a): Aquatic Life: Acute Value (2)	Statewide Standards (a): Aquatic Life: Chronic Value (2)	Statewide Standards (a): Agricultural Standard (2)	Statewide Standards (a): Domestic Water Supply (4)	Basin Standards (b): Organics: Aquatic Life	Basin Standards (b): Organics: Water Supply
Bicarbonate	A	10,000		E310 1										
Carbonate	A	10 000		E310 1										
Chloride	A	5 000		E325								250 000		
Chlorine	A	1 000		E4500					19	11				
Fluoride	A	5 000		E340								2 000		
N as Nitrate	A	5 000		E353 1							100 000	10 000		
N as Nitrate+Nitrite	A	5 000		E353 1							100,000	10 000		
N as Nitrite	A	5 000		E354 1					SS	SS	10 000	1,000		
Sulfate	A	5 000		E375 4								250 000		
Sulfide	A									2		50		
Coliform (Fecal)	B	1		SM9221C								2000/100 ml		
Ammonia as N	C	5 000		E350					620	60		500		
Dioxin	D			I	0 00000022	0.000000013	0.01	0 00001						
Sulfur	E	100 000		E600										
Dissolved Oxygen	FP	500		SM4500					5 000	5 000	3 000	3,000		
pH	FP	0 1		E150 1					6.5-9.0	6 5-9.0		5 0-9 0		
Specific Conductance	FP	1		E120 1										
Temperature	FP								30 degrees	30 degrees				
Boron	I	5 000		E6010							750			
Total Dissolved Solids	I	10,000		E160.1										
Aluminum	M	200		CT					750	87				
Antimony	M	60		CT								14		
Arsenic	M	10		CT					360	150	100	50		
Arsenic III	M													
Arsenic V	M													
Barium	M	200		CT								1,000		
Beryllium	M	5		CT							100	0.0076		
Cadmium	M	5		CT					TVS	TVS	10	10		
Calcium	M	5 000		CT										
Cesium	M	1,000		NC										
Chromium	M	10		CT										
Chromium III	M	5		SW8467196					TVS	TVS	100	50		
Chromium VI	M	10		E218.5					16	11	100	50		
Cobalt	M	50		CT										
Copper	M	25		CT					TVS	TVS	200	1 000		
Cyanide	M	10		CT					5	5	200	200		
Iron	M	100		CT						1 000		300 (dis)		
Lead	M	5		CT					TVS	TVS	100	50		
Lithium	M	100		NC										
Magnesium	M	5000		CT										
Manganese	M	15		CT						1 000	200	50 (dis)		
Mercury	M	0.2		CT					2 4	0 1		2 0		
Molybdenum	M	200		NC										
Nickel	M	40		CT					TVS	TVS	200			
Potassium	M	5000		CT										
Selenium	M	5		CT					135	17	20	10		
Silver	M	10		CT					TVS	TVS		50		
Sodium	M	5000		CT										
Strontium	M	200		NC										
Thallium	M	10		CT						15		0 012		
Tin	M	200		NC										

18/30

TABLE 3 3 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

		PQL			Statewide Standards (a)								Basin Standards (b) Organics (7)	
Parameter	Type	EPP	CDH	Method (4)	Water Supply	[illegible] Fish	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Domestic Water Supply (4)	Aquatic Life	Water Supply
Titanium	M	10		B6010										
Tungsten	M	10		B6010										
Vanadium	M	50		CT										
Zinc	M	20		CT					TVS	TVS	2,000	5 000		
2 4 5 TP Silvex	P		0 5	d	50									
2 4 D	P		1	d	100									100
Acrolein			10			320	68	21						
Aldicarb	P		10		10									
Aldrin	P	0 05	0 1	CP	0 002 (8)	0 00013	1.5						0 003	
Bromacil	P													
Carbofuran	P			d	36									
Chloranil	P			B619										
Chlordane (Alpha)	P	0 5	1	CP	0 03 (8)		1.2	0 0043						
Chlordane (Gamma)	P	0 5	1	CP	0 03 (8)	0 00058	1.2	0 0043						
Chlorpyrifos	P		0 1				0.083	0 041						
DDT	P	0 1	0 1	CP	0 1	0 00059	0.55	0 001					0 001	
DDT Metabolite (DDD)	P	0 1	0 1	CP		0.0008	0 6						0 001	
DDT Metabolite (DDE)	P	0 1	0 1	CP	0 1	0 00059	1 050						0 001	
Demeton	P		1					0 1					0 1	
Diazinon	P													
Dieldrin	P	0 1	0 1	CP	0 002	0.00014	1.3	0 0019					0 003	
Endosulfan I	P	0 05	0.1	CP		0.93	0 11	0 056					0 003	
Endosulfan II	P	0 1	0 1	CP										
Endosulfan Sulfate	P	0.1	0.1	CP		0.93								
Endrin	P	0 1	0 1	CP	0 2		0.09	0 0023					0 004	
Endrin Aldehyde	P		0 1		0 2	0.2								
Endrin Ketone	P	0 1		CP										
Guthion	P		1.5					0 01					0 01	
Heptachlor	P	0 05	0 05	CP	0 008	0 00021	0.26	0 0038					0 001	0 2
Heptachlor Epoxide	P	0 05	0 05	CP	0 09	0.0001	0.26	0 0038						
Hexachlorocyclohexane, Alpha	P	0 05	0 05	CP	0 006		0.0039							
Hexachlorocyclohexane, Beta	P	0 05	0 05	CP		0 014								
Hexachlorocyclohexane, BHC	P	0 05	0 05				100							
Hexachlorocyclohexane, Delta	P	0 05		CP										
Hexachlorocyclohexane, Tech.	P		0 2			0.012								
Hexachlorocyclohexane, Lindane	P	0 05	0 05	CP	0 2	0.019	1.0	0 08					0 01	4 0
Malathion	P		0 2					0 1					0 1	
Methoxychlor	P	0 5	0 5	CP	40			0 03					0 03	100
Mirex	P		0 1					0 001					0 001	
Parathion	P												0 04	
PCBs	P	0 5	1	CP	0 005	0.000044	2.0	0 014					0 001	
Simazine	P			a										
Toxaphene	P	1	5	CP	0 03	0.00073	0 73	0 0002					0 005	5 0
Vaponite 2	P													
Aroclor 1016	PP	0 5		CP										
Aroclor 1221	PP	0.5		CP										
Aroclor 1232	PP	0.5		CP										
Aroclor 1242	PP	0 5		CP										
Aroclor 1248	PP	0 5		CP										
Aroclor 1254	PP	1		CP										
Aroclor 1260	PP	1		CP										
Atrazine	PP			a										

19/30

TABLE 3 3 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL: EPA	PQL MDL: CDH	Method (6)	Statewide Standards (a): Human Health Carcinogenic/Noncarcinogenic (2)(3): Water Supply	Statewide Standards (a): Human Health Carcinogenic/Noncarcinogenic (2)(3): Water and Fish	Statewide Standards (a): Aquatic Life (2): Acute Value	Statewide Standards (a): Aquatic Life (2): Chronic Value	Statewide Standards (a): Tables I, II, III (1): Aquatic Life: Acute Value (3)	Statewide Standards (a): Tables I, II, III (1): Aquatic Life: Chronic Value (3)	Statewide Standards (a): Tables I, II, III (1): Agricultural Standard (3)	Statewide Standards (a): Domestic Water Supply (4)	Basin Standards (b): Organics (7): Aquatic Life	Basin Standards (b): Organics (7): Water Supply
Americium (pCi/l)	R													
Americium 241 (pCi/l)	R	0 01												
Cesium 134 (pCi/l)	R	1			80 (10)									
Cesium 137 (pCi/l)	R	1												
Gross Alpha (pCi/l)	R	2												
Gross Beta (pCi/l)	R	4												
Plutonium (pCi/l)	R													
Plutonium 238+239+240 (pCi/l)	R	0 01			15 (10)									
Radium 226+228 (pCi/l)	R	0 5/1 (9)			5 (10)									
Strontium 89+90 (pCi/l)	R	1												
Strontium 90 (pCi/l)	R				8 (10)									
Thorium 230+232 (pCi/l)	R				60 (10)									
Tritium (pCi/l)	R				20 000 (10)									
Uranium 233+234 (pCi/l)	R													
Uranium 235 (pCi/l)	R	0 6												
Uranium 238 (pCi/l)	R	0 6												
Uranium (Total) (pCi/l)	R								TVS	TVS				
1 2 4 5 Tetrachlorobenzene	SV		10	b	2 (8)									
1 2 4-Trichlorobenzene	SV	10		CS										
1 2 Dichlorobenzene (Ortho)	SV	10	1	CS	620	620								
1 2 Diphenylhydrazine	SV			b	0 05	0.04	270							
1 3 Dichlorobenzene (Meta)	SV	10	1	CS	620	400								
1 4 Dichlorobenzene (Para)	SV	10	1	CS	75	75								
2 4 5-Trichlorophenol	SV	50		CS										
2 4 6-Trichlorophenol	SV	10	50	CS	2	2		970						
2 4-Dichlorophenol	SV	10	50	CS	21	21	2 020	365						
2 4-Dimethylphenol	SV	10	50	CS			2,120							
2 4-Dinitrophenol	SV	50	50	CS	14	14								
2 4-Dinitrotoluene	SV	10	10	CS		0 11								
2 6-Dinitrotoluene	SV	10	10	CS			330	230						
2 Chloronaphthalene	SV	10		CS										
2 Chlorophenol	SV	10	50	CS			4,380	2 000						
2 Methylnaphthalene	SV	10		CS										
2 Methylphenol	SV	10		CS										
2 Nitroaniline	SV	50		CS										
2 Nitrophenol	SV	10		CS										
3 3 Dichlorobenzidine	SV	20	10	CS		0.039								
3 Nitroaniline	SV	50		CS										
4 6-Dinitro 2-methylphenol	SV	50	50	CS		13								
4-Bromophenyl Phenylether	SV	10		CS										
4 Chloroaniline	SV	10		CS										
4 Chlorophenyl Phenyl Ether	SV	10		CS										
4 Chloro-3 methylphenol	SV	10	50	CS			30							
4 Methylphenol	SV	10		CS										
4 Nitroaniline	SV	50		CS										
4-Nitrophenol	SV	50		CS										
Acenaphthene	SV	10	10	CS			1 700	520						
Anthracene	SV	10	1	CS		0.0028								
Benzidine	SV		10	d	0 0002	0.00012(8)	2,500						0 1	0 01
Benzoic Acid	SV	50		CS										
Benzo(a)anthracene	SV	10	10	CS		0.0028								
Benzo(a)pyrene	SV	10	10	CS		0.0028								
Benzo(b)fluoranthene	SV	10	10	CS		0.0028								

20/30

TABLE 3 3 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL: PPP	PQL MDL: CDH	Method (6)	Statewide Standards (a): Human Health Carcinogenic/Noncarcinogenic (2)(8): Water Supply	Statewide Standards (a): Human Health Carcinogenic/Noncarcinogenic (2)(8): Water and Fish	Statewide Standards (a): Aquatic Life (8): Acute Value	Statewide Standards (a): Aquatic Life (8): Chronic Value	Statewide Standards (a): Tables (1)(3) Aquatic Life: Acute Value (2)	Statewide Standards (a): Tables (1)(3) Aquatic Life: Chronic Value (2)	Statewide Standards (a): Agricultural Standard (3)	Statewide Standards (a): Domestic Water Supply (4)	Basin Standards (b) Organics (7): Aquatic Life	Basin Standards (b) Organics (7): Water Supply
Benzo(g h,i)perylene	SV	10	10	CS		0.0028								
Benzo(k)fluoranthene	SV	10	10	CS		0 0028								
Benzyl Alcohol	SV	10		CS										
bis(2 Chloroethoxy)methane	SV	10		CS										
bis(2 Chloroethyl)ether	SV	10	10	CS	0 03 (8)	0 03 (8)								
bis(2 Chloroisopropyl)ether	SV	10	10	CS		1 400								
bis(2 Ethylhexyl)phthalate	SV	10	10	CS		1.8 (8)								
Butadiene	SV													
Butyl Benzylphthalate	SV	10	10	CS		3 000								
Chlorinated Ethers	SV													
Chlorinated Napthalenes	SV													
Chloroalkylethers	SV	10		CS										
Chlorophenol	SV		50										1 0	1 0
Chrysene	SV	10	10	CS		0 0028								
Dibenzofuran	SV	10		CS										
Dibenz(a,h)anthracene	SV	10	10	CS		0 0028								
Dichlorobenzenes	SV		1											
Dichlorobenzidine	SV	20	10	CS		0.039								
Diethylphthalate	SV	10	10	CS		23 000								
Dimethylphthalate	SV	10	10	CS		313 000								
Di-n butylphthalate	SV	10	10	CS		2 700								
Di-n octylphthalate	SV	10		CS										
Ethylene Glycol	SV			d										
Fluoranthene	SV	10	10	CS		42	3 980							
Fluorene	SV	10	10	CS		0.0028								
Formaldehyde	SV													
Haloethers	SV													
Hexachlorobenzene	SV	10	10	CS	6	0 00072								
Hexachlorobutadiene	SV	10	10	CS	1	0.45	90	9 3						
Hexachlorocyclopentadiene	SV	10	10	CS		240	7	5						
Hexachloroethane	SV	10	10	CS		1 9	980	540						
Hydrazine	SV													
Indeno(1,2 3 cd)pyrene	SV	10	10	CS		0 0028								
Isophorone	SV	10	10	CS	1 050	8.4	117,000							
Naphthalene	SV	10	10	CS		0.0028	2,300	620						
Nitrobenzene	SV	10	10	CS	3 5	3.5	27,000							
Nitrophenols	SV													
Nitrosamines	SV													
Nitrosodibutylamine	SV		10	b		0 0064								
Nitrosodiethylamine	SV		10	b		0 0008								
Nitrosodimethylamine	SV		10	b		0 00069								
Nitrosopyrrolidine	SV		10	b		0 016								
N Nitrosodiphenylamine	SV	10	10	CSb		4 9								
N Nitroso-di n dipropylamine	SV	10	10	CSb		0 005								
Pentachlorinated Ethanes	SV			b										
Pentachlorobenzene	SV		10	b	6 (8)									
Pentachlorophenol	SV	50	50	CS	200		9	5 7						
Phenanthrene	SV	10	10	CS		0.0028								
Phenol	SV	10	50	CS		21,000	10,200	2 560					500	1 0
Phthalate Esters	SV			e										
Polynuclear Aromatic Hydrocarbons	SV		10	b		0 0028								
Vinyl Chloride	SV	10	2	CV	2	2								
1 1 1 Trichloroethane	V	5	1	CV	200	200								

21/30

TABLE 3 3 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Statewide Standards (a): Human Health Carcinogenic/Noncarcinogenic (2)(8): Water Supply	Human Health: Water and Fish	Aquatic Life (3): Acute Value	Aquatic Life (3): Chronic Value	Tables (1)(2)(3): Aquatic Life: Acute Value (3)	Tables: Aquatic Life: Chronic Value (3)	Agricultural Standard (3)	Domestic Water Supply (4)	Basin Standards (b): Organics (7): Aquatic Life	Basin Standards (b): Organics (7): Water Supply
1 1 2,2 Tetrachloroethane	V	5	1	CV		0 17		2,400						
1 1 2 Trichloroethane	V	5	1	CV	3	0 6	9 400							
1 1 Dichloroethane	V	5		CV										
1 1 Dichloroethene	V	5	1	CV	7	0 057								
1 2 Dichloroethane	V	5	1	CV	0 4	0 4	118 000	20 000						
1 2 Dichloroethene (cis)	V		1	a	70									
1 2 Dichloroethene (total)	V	5		CV										
1 2 Dichloroethene (trans)	V	5	1	a	100									
1 2 Dichloropropane	V	5	1	CV	0 56 (8)	0.56	23,000	5 700						
1 3 Dichloropropene (cis)	V	5	1	CV		10	6 060	244						
1 3 Dichloropropene (trans)	V	5	1	CV		10	6,060	244						
2 Butanone	V	10		CV										
2 Hexanone	V	10		CV										
4-Methyl 2 pentanone	V	10		CV										
Acetone	V	10		CV										
Acrylonitrile	V		5	c		0.58	7,550	2 600						
Benzene	V	5	1	CV	1	1	5,300							
Bromodichloromethane	V	5	1	CV	0 3	0.3								
Bromoform	V	5	1	CV	4	4								
Bromomethane	V	10	1	CV		48								
Carbon Disulfide	V	5		CV										
Carbon Tetrachloride	V	5	1	CV	0 3	0.25	35,200							
Chlorinated Benzenes	V	10		CV/CS										
Chlorobenzene	V	5	1	CV/CVS	100	100								
Chloroethane	V	10		CV										
Chloroform	V	5	1	CV	6	6	28,900	1 240						
Chloromethane	V	10	1	CV		5 7								
Dibromochloromethane	V	5	1	CV	14	6								
Dichloroethenes	V		1											
Ethyl Benzene	V	5	1	CV	680	3 100	32,000							
Ethylene Dibromide	V			d										
Ethylene Oxide	V													
Halomethanes	V				100									
Methylene Chloride	V	5	1	CV		4 7								
Pyrene	V	10	10	CS		0 0028								
Styrene	V	5		CV										
Tetrachloroethanes	V	5	1	CV										
Tetrachloroethene	V	5	1	CV	5	0.8	5,280	840						
Toluene	V	5	1	CV	1 000	1,000	17,500							
Trichloroethanes	V	5	1	CV										
Trichloroethene	V	5	1	CV	5	2 7	45,000	21 900						
Vinyl Acetate	V	10		CV										
Xylenes (Total)	V	5		CV										

22/30

TABLE 3 3 POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogenic/ Noncarcinogenic (2) (8)		[illegible] Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
		PQL MDL							Aquatic Life					
Parameter	Type (5)	RFP	CDH	Method (6)	Water Supply	Water and Fish	Acute Value [illegible]	Chronic Value	Acute Value (2)	Chronic Value (3)	Agricultural [illegible] Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply

EXPLANATION OF TABLE

CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
dis	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
SS	= species specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
TVS	= Table Value Standard (hardness dependent), see Table III in (a)
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
CWQCC	= Colorado Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I II, and III for recreational uses cold water biota and domestic water supply are not included.
(2) In the absence of specific numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Ammonia sulfide, chloride, sulfate, copper iron, manganese, and zinc are 30-day standards, all others are 1 day standards
(5) type abbreviations are. A=anion B=bacteria, C=cation, I=indicator; FP=field parameter; M=metal; P= pesticide; PP=pesticide/PCB R=radionuclide; SV=semi-volatile V=volatile
(6) method abbreviations are: CT=CLP TAL, NC=non-CLP CV=CLP VOA CS=CLP-SEMI, EP=EPA PEST CP=CLP-PEST; E=EPA; a = detected as total in CV, b = detected as TICs in CS c = detected as TIC in CV d = not routinely monitored e = monitored in discharge ponds f = mixture-individual isomers detected.
(7) See Section 3.8.5 (2)(a) in (b)
(8) Where standard is below (more stringent than) PQL (CDH), PQL is standard.
(9) MDL for Radium 226 is 0.5 MDL for Radium 228 is 1.0
(10) See section 3 1 11 (f) (2) in (a)

(a) CDH/CWQCC Colorado Water Quality Standards 3 1 0 (5 CCR 1002 8) 1/15/1974 amended 10/17/1991 (ARAR).
(Environmental Reporter 726:1001 (020-6/1990)
(b) CDH/CWQCC Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8 0 (5 CCR 1002 8) 4/6/1981 amended 2/15/1990 Basin wide standards are ARAR

23/30

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
Bicarbonate	A	10,000		E310 1							
Carbonate	A	10,000		E310 1							
Chloride	A	5 000		E325				250 000	250 000		
Chlorine	A	1 000		E4500				3	3		
Fluoride	A	5 000		E340							
N as Nitrate	A	5 000		E353 1				10 000	10 000		
N as Nitrate+Nitrite	A	5 000		E353 1							
N as Nitrite	A	5 000		E354 1				1 000	1 000		
Sulfate	A	5 000		E375 4				250 000	250 000		
Sulfide	A										
Coliform (Fecal)	B	1		SM9221C							
Ammonia as N	C	5 000		E350				620	60		
Dioxin	D			4	0 00000022	0 000000013			0 000000013		
Sulfur	E	100 000		E600				2 0	2 0		
Dissolved Oxygen	FP	500		SM4500				5 000	5 000		
pH	FP	0 1		E150 1				6 5 9	6 5-9		
Specific Conductance	FP	1		E120 1							
Temperature	FP										
Boron	I	5 000		E6010				750	750		
Total Dissolved Solids	I	10,000		E160 1							
Aluminum	M	200		CT							
Antimony	M	60		CT							
Arsenic	M	10		CT				50			
Arsenic III	M										
Arsenic V	M										
Barium	M	200		CT							
Beryllium	M	5		CT							
Cadmium	M	5		CT				TVS	TVS		
Calcium	M	5 000		CT							
Cesium	M	1 000		NC							
Chromium	M	10		CT							
Chromium III	M	5		SW8467196				50			
Chromium VI	M	10		E218 5				TVS	TVS		
Cobalt	M	50		CT							
Copper	M	25		CT				TVS	TVS		
Cyanide	M	10		CT				5	5		
Iron	M	100		CT					300 (3)		
Lead	M	5		CT				TVS	TVS		
Lithium	M	100		NC							
Magnesium	M	5000		CT							
Manganese	M	15		CT					50 (3)		
Mercury	M	0.2		CT					0 01		
Molybdenum	M	200		NC							

24/30

TABLE 3 4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
Nickel	M	40		CT				TVS	TVS		
Potassium	M	5000		CT							
Selenium	M	5		CT				10			
Silver	M	10		CT				TVS	TVS		
Sodium	M	5000		CT							
Strontium	M	200		NC							
Thallium	M	10		CT							
Tin	M	200		NC							
Titanium	M	10		E6010							
Tungsten	M	10		E6010							
Vanadium	M	50		CT							
Zinc	M	20		CT				TVS	TVS		
2 4 5 TP Silvex	P		0 5	[illegible]	10						
2 4-D	P		1	[illegible]	100						
Acrolein	P		10								
Aldicarb	P		10		10						
Aldrin	P	0 05	0 1	CP	0 002 (6)	0 000074			0 000074		
Bromacil	P										
Carbofuran	P			[illegible]	36						
Chloranil	P			E619							
Chlordane (Alpha)	P	0 5	1	CP	0 03 (6)	0 00046			0 00046		
Chlordane (Gamma)	P	0 5	1	CP	0 03 (6)	0 00046			0 00046		
Chlorpyrifos	P		0 1								
DDT	P	0 1	0 1	CP	0 1 (6)	0 000024			0 000024		
DDT Metabolite (DDD)	P	0 1	0 1	CP							
DDT Metabolite (DDE)	P	0 1	0 1	CP							
Demeton	P		1								
Diazinon	P										
Dieldrin	P	0 1	0 1	CP	0 002 (6)	0 000071			0 000071		
Endosulfan I	P	0 05	0 1	CP							
Endosulfan II	P	0 1	0 1	CP							
Endosulfan Sulfate	P	0 1	0 1	CP							
Endrin	P	0 1	0 1	CP	0 2						
Endrin Aldehyde	P		0 1								
Endrin Ketone	P	0 1		CP							
Guthion	P		1 5								
Heptachlor	P	0 05	0 05	CP	0 008 (6)	0 00028			0 00028		
Heptachlor Epoxide	P	0 05	0 05	CP	0 004 (6)						
Hexachlorocyclohexane, Alpha	P	0 05	0 05	CP		0 0092			0 0092		
Hexachlorocyclohexane, Beta	P	0 05	0 05	CP		0 0163			0 0163		
Hexachlorocyclohexane, BHC	P	0 05	0 05								
Hexachlorocyclohexane, Delta	P	0 05		CP							
Hexachlorocyclohexane, Tech.	P		0 2	[illegible]		0 0123			0 0123		
Hexachlorocyclohexane Lindane	P	0 05	0 05	CP	4	0 0186			0 0186		
Malathion	P		0 2								

25/30

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL		Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		RFP	CDH		Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
Methoxychlor	P	0 5	0 5	CP	100						
Mirex	P		0 1								
Parathion	P										
PCBs	P	0 5	1	CP	0 005 (6)	0 000079			0 000079		
Simazine	P			e		4			4		
Toxaphene	P	1	5	CP	5						
Vaponite 2	P										
Aroclor 1016	PP	0 5		CP							
Aroclor 1221	PP	0 5		CP							
Aroclor 1232	PP	0 5		CP							
Aroclor 1242	PP	0 5		CP							
Aroclor 1248	PP	0 5		CP							
Aroclor 1254	PP	1		CP							
Aroclor 1260	PP	1		CP							
Atrazine	PP			e		3			3		
Americium (pCi/l)	R									0 05	0 05
Americium 241 (pCi/l)	R	0 01					30				
Cesium 134 (pCi/l)	R	1			80		80			80	80
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCi/l)	R	2								7	11
Gross Beta (pCi/l)	R	4								5	19
Plutonium (pCi/l)	R									0 05	0 05
Plutonium 238+239+240 (pCi/l)	R	0 01					15				
Radium 226+228 (pCi/l)	R	0 5/1 0 (7)					5				
Strontium 89+90 (pCi/l)	R	1									
Strontium 90 (pCi/l)	R						8			8	8
Thorium 230+232 (pCi/l)	R						60				
Tritium (pCi/l)	R						20 000			500	500
Uranium 233+234 (pCi/l)	R										
Uranium 235 (pCi/l)	R	0 6									
Uranium 238 (pCi/l)	R	0 6									
Uranium (Total) (pCi/l)	R						40			5	10
1 2 4,5 Tetrachlorobenzene	SV		10	b	2 (6)						
1 2 4-Trichlorobenzene	SV	10		CS							
1 2 Dichlorobenzene (Ortho)	SV	10	1	CS	620						
1,2 Diphenylhydrazine	SV			b	0 05 (6)						
1 3-Dichlorobenzene (Meta)	SV	10	1	CS	620						
1 4-Dichlorobenzene (Para)	SV	10	1	CS	75						
2 4 5-Trichlorophenol	SV	50		CS	700						
2 4 6-Trichlorophenol	SV	10	50	CS	2.0 (6)	1 2			1 2		
2 4 Dichlorophenol	SV	10	50	CS	21 (6)						
2 4-Dimethylphenol	SV	10	50	CS							
2 4 Dinitrophenol	SV	50	50	CS							
2 4 Dinitrotoluene	SV	10	10	CS							

26/30

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5): Acute Value	Stream Segment Table (5): Chronic Value	Table 2 Radionuclides: Woman Creek	Table 2 Radionuclides: Walnut Creek
2 6 Dinitrotoluene	SV	10	10	CS							
2 Chloronaphthalene	SV	10		CS							
2 Chlorophenol	SV	10	50	CS							
2 Methylnaphthalene	SV	10		CS							
2 Methylphenol	SV	10		CS							
2 Nitroaniline	SV	50		CS							
2 Nitrophenol	SV	10		CS							
3 3 Dichlorobenzidine	SV	20	10	CS		0 01			0 01		
3 Nitroaniline	SV	50		CS							
4 6-Dinitro 2 methylphenol	SV	50	50	CS							
4 Bromophenyl Phenylether	SV	10		CS							
4 Chloroaniline	SV	10		CS							
4 Chlorophenyl Phenyl Ether	SV	10		CS							
4 Chloro-3 methylphenol	SV	10	50	CS							
4 Methylphenol	SV	10		CS							
4-Nitroaniline	SV	50		CS							
4-Nitrophenol	SV	50		CS							
Acenaphthene	SV	10	10	CS							
Anthracene	SV	10	1	CS							
Benzidine	SV		10	d	0 0002 (6)	0 00012			0 00012		
Benzoic Acid	SV	50		CS							
Benzo(a)anthracene	SV	10	10	CS							
Benzo(a)pyrene	SV	10	10	CS							
Benzo(b)fluoranthene	SV	10	10	CS							
Benzo(g,h i)perylene	SV	10	10	CS							
Benzo(k)fluoranthene	SV	10	10	CS							
Benzyl Alcohol	SV	10		CS							
bis(2 Chloroethoxy)methane	SV	10		CS							
bis(2 Chloroethyl)ether	SV	10	10	CS	0 03 (6)	0 0000037			0 0000037		
bis(2 Chloroisopropyl)ether	SV	10	10	CS							
bis(2 Ethylhexyl)phthalate	SV	10	10	CS							
Butadiene	SV										
Butyl Benzylphthalate	SV	10		CS							
Chlorinated Ethers	SV										
Chlorinated Napthalenes	SV										
Chloroalkylethers	SV	10		S							
Chlorophenol	SV		50								
Chrysene	SV	10	10	CS							
Dibenzofuran	SV	10		CS							
Dibenz(a,h)anthracene	SV	10	10	CS							
Dichlorobenzenes	SV		1								
Dichlorobenzidine	SV	20	10	CS		0 01			0 01		
Diethylphthalate	SV	10	10	CS							
Dimethylphthalate	SV	10	10	CS							
Di n butylphthalate	SV	10	10	CS							
Di n octylphthalate	SV	10		CS							

27/30

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5): Acute Value	Stream Segment Table (5): Chronic Value	Table 2 Radionuclides: Woman Creek	Table 2 Radionuclides: Walnut Creek
Ethylene Glycol	SV			d							
Fluoranthene	SV	10	10	CS							
Fluorene	SV	10	10	CS							
Formaldehyde	SV										
Haloethers	SV										
Hexachlorobenzene	SV	10	10	CS	0 02 (6)	0 00072			0 00072		
Hexachlorobutadiene	SV	10	10	CS	14	0 45			0 45		
Hexachlorocyclopentadiene	SV	10	10	CS	49						
Hexachloroethane	SV	10	10	CS		1 9			1 9		
Hydrazine	SV										
Indeno(1,2 3 cd)pyrene	SV	10	10	CS							
Isophorone	SV	10	10	CS	1 050						
Naphthalene	SV	10	10	CS							
Nitrobenzene	SV	10	10	CS	3 5 (6)						
Nitrophenols	SV										
Nitrosamines	SV										
Nitrosodibutylamine	SV		10	b		0 0064			0 0064		
Nitrosodiethylamine	SV		10	b		0 0008			0 0008		
Nitrosodimethylamine	SV		10	b		0 0014			0 0014		
Nitrosopyrrolidine	SV		10	b		0 016			0 016		
N Nitrosodiphenylamine	SV	10	10	CSb		4 9			4 9		
N Nitroso-di n-dipropylamine	SV	10	10	CSb							
Pentachlorinated Ethanes	SV			b							
Pentachlorobenzene	SV		10	b	6 (6)						
Pentachlorophenol	SV	50	50	CS	200						
Phenanthrene	SV	10	10	CS							
Phenol	SV	10	50	CS							
Phthalate Esters	SV			c							
Polynuclear Aromatic Hydrocarbons	SV		10	b		0 0028			0 0028		
Vinyl Chloride	SV	10	2	CV	2						
1 1 1 Trichloroethane	V	5	1	CV	200						
1 1 2,2 Tetrachloroethane	V	5	1	CV		0 17			0 17		
1 1 2 Trichloroethane	V	5	1	CV	28	0 60			0 60		
1 1 Dichloroethane	V	5		CV							
1 1 Dichloroethene	V	5	1	CV	7						
1 2 Dichloroethane	V	5	1	CV	5						
1 2 Dichloroethene (cis)	V		1	a	70						
1 2 Dichloroethene (total)	V	5		CV							
1,2 Dichloroethene (trans)	V	5	1	a	70						
1 2 Dichloropropane	V	5	1	CV	0.56 (6)						
1 3-Dichloropropene (cis)	V	5	1	CV							
1 3 Dichloropropene (trans)	V	5	1	CV							
2 Butanone	V	10		CV							
2 Hexanone	V	10		CV							
4-Methyl 2 pentanone	V	10		CV							

28/30

TABLE 3 4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4): Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5): Acute Value	Stream Segment Table (5): Chronic Value	Table 2 Radionuclides: Woman Creek	Table 2 Radionuclides: Walnut Creek
Acetone	V	10		CV							
Acrylonitrile	V		5	C		0 058			0 058		
Benzene	V	5	1	CV	5						
Bromodichloromethane	V	5	1	CV							
Bromoform	V	5	1	CV							
Bromomethane	V	10	1	CV							
Carbon Disulfide	V	5		CV							
Carbon Tetrachloride	V	1		CV	5						
Chlorinated Benzenes	V	10		CV/CS							
Chlorobenzene	V	5	1	CV/CVS	300						
Chloroethane	V	10		CV							
Chloroform	V	5	1	CV	Tot THM <100*	0 19			0 19		
Chloromethane	V	10	1	CV							
Dibromochloromethane	V	5	1	CV							
Dichloroethenes	V		1								
Ethyl Benzene	V	5	1	CV	680						
Ethylene Dibromide	V			I							
Ethylene Oxide	V										
Halomethanes	V				100	0 19			0 19		
Methylene Chloride	V	5	1	CV							
Pyrene	V	10	10	CS							
Styrene	V	5		CV							
Tetrachloroethanes	V	5	1	CV		0.8			0 8		
Tetrachloroethene	V	5	1	CV	10						
Toluene	V	5	1	CV	2,420						
Trichloroethanes	V	5	1	CV							
Trichloroethene	V	5	1	CV	5						
Vinyl Acetate	V	10		CV							
Xylenes (Total)	V	5		CV							

29/30

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992) STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL						Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)	Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek

EXPLANATION OF TABLE

*	= Total trihalomethanes chloroform, bromoform bromodichloromethane, dibromochloromethane
CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
ds	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
RFP	= Rocky Flats Plant
SS	= species specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
TVS	= Table Value Standard (hardness dependent), see Table III in (a)
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analytes
CWQCC	= Colorado Water Quality Control Commission

(1) In the absence of specific numeric standards for non-naturally occurring organics the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/CWQCC or EPA
(2) Ammonia sulfide, chloride, sulfate copper iron manganese, and zinc are 30-day standards all others are 1-day standards
(3) Lowest value given. dissolved or total recoverable
(4) Segment 5 standards are goals
(5) Includes Table 1 Additional Organic Chemical Standards (chronic only)
(6) Standard is below (more stringent than) PQL, therefore PQL is standard.
(7) MDL for Radium 226 is 0 5 MDL for Radium 228 is 1 0

(a) CDH/CWQCC Colorado Water Quality Standards 3 1 0 (5 CCR 1002 8) 1/15/1974, amended 9/30/1989 (Envrionmental Reporter 726 1001-1020 6/1990)
(b) CDH/CWQCC Classifications and Numeric Standards for S Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002 8) 4/6/1981, amended 2/15/1990

30/30

Approved by:

Manager, Remediation Programs 6/28/94 RFI Project Manager 6/28/94

4.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

4 1 TASK 1 - PROJECT PLANNING

Project planning will include numerous activities as part of the implementation of the Phase I RFI/RI for OU8 in addition to those outlined in this Work Plan. Activities undertaken for development of this Work Plan has included reviews of previous investigations and site characterization data, historical aerial photographs and maps, evaluation of existing data, and review of other related documents. Results of this review are presented in Section 2.0 of this Work Plan. Additionally, results of this review have been utilized in developing Section 3.0 - Chemical-Specific Benchmarks, Section 5.0 - DQOs, and Section 6.0 - FSP. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which will become available after preparation of this Work Plan.

Ongoing site studies at RFP of surface water and sediments, groundwater, geology, background geochemistry, and ambient air may provide data that have bearing on the investigations in the 700 area These data will be compiled and evaluated during the project planning activities. Data from investigations at overlapping OUs (e.g., OU4, 6, 9, 10, and 14) will also be reviewed. If available data from ongoing investigations meet the requirements of the Phase I FSP, the samples proposed in Section 6.0 need not be collected again.

It is important to emphasize that project planning and coordination will be required throughout implementation and duration of the Work Plan to accommodate any unforeseen developments.

Two project planning documents, one included in this work plan, have been prepared for the OU12 RFI/RI as required by the IAG. The FSP included in this document presents the locations, media, and frequency of sampling efforts. The second document required by the IAG is a Sampling and Analysis Plan (SAP) which includes a QAPjP and SOPs for all field activities A site-wide SAP has been prepared for the RFP, and is currently being revised in accordance with the IAG. QA procedures and SOPs that are used specifically for OU8 are referenced in this work plan. Any deviations from the QAPjP or SOPs are documented as QA Addenda in Section 10.0 of this work plan, or as Document Change Notices (DCNs) to the SOPs.

4.2 TASK 2 - COMMUNITY RELATIONS

In accordance with the IAG, the RFP has developed a Community Relations Plan (CRP) to inform and actively involve the public in decision-making as it relates to environmental restoration activities. This CRP meets the requirements of all OUs. The vehicle for the public involvement in the RFI/RI process is through the Technical Review Group process. The CRP addresses the needs and concerns of the surrounding communities as identified through interviews with federal, state, and local elected officials; businesses; medical professionals; educational representatives, interest groups; media; and residents adjacent to the RFP.

Current community relations activities concerning environmental restoration include participation by RFP representatives in informational workshops; presentations at meetings of the Rocky Flats Environmental Monitoring Council; briefings for citizens, businesses, and surrounding communities on environmental restoration and monitoring activities; and public comment opportunities on various Environmental Management (EM) Program plans and actions. RFP personnel involve several special interest groups in decisions that pertain to environmental restoration activities, including the Rocky Flats Cleanup Commission, the recipient of the EPA Technical Assistant Grant.

In addition, a Speakers' Bureau program provides RFP speakers to civic groups and education organizations, and a public tours program allows the public to visit the RFP. The RFP also produces fact sheets and periodic updates on environmental restoration activities for public information and responds to numerous public inquiries regarding the RFP.

4.3 TASK 3 - FIELD INVESTIGATION

Phase I field investigations will be conducted at the IHSSs in the 700 Area to collect samples and data concerning the nature and extent of contamination, if any, at each site. The data and sample results will be used to meet the objectives and data needs described in Section 5.0 of this Work Plan and support the Phase I EE and Phase I Human Health Risk Assessment (HHRA). Additional stage(s) of investigation may be required depending on the results from implementation of the initial stages in this Work Plan.

Several types of staged activities are planned to be performed during the Phase I RFI/RI field-investigation: coordination with RFP departments and engineering design review, site screening and investigations, media sampling, installation of soil borings, leachability tests, vadose zone investigations, and groundwater well installation and monitoring. Screening activities include visual inspections, radiological surveys, organic vapor measurements using portable instruments, radiological screening of borehole samples, and soil-gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, saturated zone sampling, surface water sampling, and sediment sampling.

Twenty-four IHSSs have been included in OU8 in the 700 Area. These IHSSs have been grouped into three groups based on the contaminant source type and release mechanism of the sites. Because of the diverse nature of the IHSS groups, the Phase I field investigations for each group will be different. Specific field activities are described in the Phase I FSP in Section 6.0 of this Work Plan.

4 4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the FSP as described in Section 6.0. Analytical procedures will be completed in accordance with the ER Program QAPjP. Project-specific quality assurance (QA) requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this Work Plan. Section 6.0 of this Work Plan contains Phase I analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this Work Plan will be analyzed by an RFP contract laboratory.

Phase I data will be reviewed and checked according to the guidelines in the QAPjP and the Data Validation Functional Guidelines. These documents state that the results of data review and validation activities will be documented in data validation reports.

4 5 TASK 5 - DATA EVALUATION

Data collected during the Phase I RFI/RI will be incorporated into the existing RFEDS database with data from investigations at other Ous. The data will be used to better define site characteristics, source characteristics, the nature and extent of contamination, to support the Human Health Risk Assessment and Environmental Evaluation, and to evaluate potential remedial alternatives. Screening data will be collected and stored on independent databases and will be transformed to the RFEDS database when appropriate.

4.5.1 Site Characterization

The data collected during the Phase I RI will be evaluated to identify potential sources of contamination at the IHSSs. Potential sources include wastes disposed at the sites and off-site sources located topographically and/or hydraulically upgradient of the sites. Analytical data from soil and sediment sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

Geologic and hydrogeologic data will be used to develop site maps and cross sections At IHSSs where boreholes and/or monitoring wells are planned to be installed, geologic data will be used to evaluate the stratigraphy of the alluvium and colluvium at each site Where the installation of borehole or monitoring wells is sufficient to penetrate bedrock, the depth and lithologic type of the bedrock will be determined.

Hydrogeologic data collected from this investigation and from other previously (or concurrently, if available) conducted studies will be used to characterize the unconfined aquifer gradient and water table configuration at the IHSSs. These data will include information about the following:

- Hydrostratigraphic characteristics of units present;
- Hydraulic gradients; and
- Water table depth and configuration.

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale may be conducted. Prior to initiating any fate and transport modeling efforts, a technical memorandum will be submitted as per Attachment 2, Section VII.D.1.b., of the IAG. This technical memorandum will describe the models which will be utilized and include a summary of those data which will be modeled.

To characterize the general surface-water system of OU8, a regional scale surface-water flow and transport model may be developed. Where required, IHSS specific flow and transport models may be developed and integrated to the regional scale model. Details will be discussed in a technical memorandum prior to its implementation.

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize the 700 Area.

Surficial soils and materials (i.e., concrete, asphalt, gravel, backfill, etc.) covering each IHSS will be described and characterized based on results of investigations in Stages 2, 3, 4, and 5. During Stage 1, the paving and construction history of the IHSS will be researched prior to implementing investigation and sampling activities. Results of site screening investigation (i.e., radiation surveys, soil-gas, as vertical depth (soil) profile sampling, pavement sampling, etc.) will be evaluated and described using approved SOPs. Characterization will include description of the lateral and vertical extent of the soils and materials including contamination type and concentrations present. Proximity, mobility, and potential impacts to surficial soil (and materials), surface water, sediments, vadose zone and the saturated zone (groundwater) will be evaluated and results presented in the Technical Memoranda following each investigation stage.

In addition to a discussion of investigation results; tables, figures, and maps depicting the location and extent of surveys and sampling sites will be provided. Rationale and recommendations for subsequent investigations and target contaminants will be presented.

4.5.2 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to estimate the concentrations and distributions of the contaminants. Results of sampling will be compared with results of the ongoing background geochemical characterization to assess the chemical concentrations above background levels. Products of this analysis may include isopleth maps, cross sections and profiles, chemical tables, and statistical results.

4 5.3 Air

Atmospheric transport is characterized by short migration times, relatively large areas of exposure, and an inability to mitigate the potential consequences of a contaminant release once it occurs. As such, effective air pathway contaminant control will emphasize source emissions reduction and containment prior to atmospheric release. Conventional technologies that may be employed during OU8 Work Plan implementation to suppress fugitive dust and volatile organic emissions include application of water sprays, surfactants, or dust suppressants and installation of wind-screens or membrane coverings. Such methods will be applied when personnel protection monitoring (as implemented according to the Site-Specific Health and Safety Plan) indicates the need for mitigative action during Work Plan implementation.

Air dispersion modeling may also be conducted and will be discussed in a technical memorandum prior to its implementation.

4 6 TASK 6 - PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared as required by the IAG, for OU8 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether additional investigations are necessary at the IHSSs and whether remedial actions are necessary.

The risk assessment will be accomplished in four general steps:

- Identification of chemicals of concern;
- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no action alternative (no remedial action taken) based on the data available This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Human Health Risk Assessment Plan for OU8, Section 8.0 of this Work Plan. The Environmental Evaluation for OU8 is Section 9.0 of this Work Plan.

4.7 TASK 7 - DEVELOPMENT, SCREENING, AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

Remedial action alternatives reflect remedial action objectives aimed at protecting human health and the environment and should specify contaminants, exposure routes and receptors, and a preliminary remediation goal (e.g., an acceptable contaminant range).

4 7.1 Remedial Alternatives, Development and Screening

This section identifies potential technologies applicable to remediation of contaminated surficial materials (i.e., surficial soils, artificial fill, and alluvium), vadose zone, surface water, saturated zone (groundwater), and sediments. The identified technologies are based on the preliminary site characterization described in Sections 2.3, 2.4, and 2.5. Identification and screening of technologies and assembling an initial screening of alternatives will be conducted simultaneously with the Phase I RFI/RI. However, investigation of this OU is in its early stages; thus, remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives for OU8 will be performed as results are obtained during implementation of the Phase I RFI/RI.

OU8 is a joint lead CERCLA operable unit involving the CDH and EPA (CDH handles dispute resolution (DOE, 1991, Table 3) and as such the processes employed to develop and evaluate alternatives for OU8 are outlined in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988a). As stated in the IAG, general compliance with both RCRA and CERCLA is required for this OU. However, the outline presented in the CERCLA Guidelines provides the greatest detail for selection of remedial alternatives.

The steps followed to develop preliminary remedial alternatives for OU8 are as follows:

1. Develop remedial action objectives specifying exposure pathways and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed for sources and soils on the basis of chemical-specific benchmarks and site-specific risk-related factors. These goals will be developed as site characterization data and information from the BRA become available.

2. Develop a list of actions (such as containment, treatment, and/or removal) appropriate for surficial soils (and materials), vadose zone, saturated zone (groundwater), surface water and sediments, and air at OU8 that may be implemented to satisfy the objectives defined in the previous step. These actions are generally referred to as "general response actions" in EPA guidelines.

3. Identify and screen technology groups for each general response action. General response actions can each be further defined to include groups of technologies by which an action can be accomplished. Screening will eliminate those groups that are not technically feasible at the site.

4. Identify and evaluate process options for each technology group to select a process option representing each technology group under consideration. Although specific process options are selected to represent a technology group for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group.

5. Assemble the selected representative technologies into site closure and corrective action alternatives for the surficial soils (and materials), vadose zone, saturated zone (groundwater), surface water and sediments, and air of the IHSS areas of OU8 that represent a range of treatment and containment combinations, as appropriate.

6 Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the screening evaluation reduces the number of alternatives that will undergo thorough and extensive analyses, alternatives will be evaluated in less detail than subsequent evaluations.

7. Develop preliminary cancer risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. As the CMS/FS evolves, preliminary remediation goals may be revised.

Determining the effectiveness of alternatives involves an evaluation of the protection of human health and the environment achieved by a remedial action during construction and implementation and after the response objectives have been met. Evaluation of short-term effectiveness is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term effectiveness addresses the risk remaining to human health and the environment. It is based on the percentage of permanent destruction, decreased mobility, and/or reduction in volume of toxic compounds achieved after response objectives have been met.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to the site-specific conditions. Technical feasibility refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. Administrative feasibility refers to the ability to obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for similar sites at RFP, with modifications made for current RFP conditions. Precise estimates are not necessary. However, the cost estimates for comparison and screening will have the same relative accuracy. The cost estimating procedures used during screening are similar to those that will be used during the later detailed alternatives analyses. However, the later detailed analysis will receive more in-depth and detailed estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment operations at the site. Present worth cost analysis will be used to make the costs for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than ten alternatives will be retained for detailed analysis (including containment and no action). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. It will also be necessary to identify and verify the action-specific ARARs for each alternative.

The Phase I RFI/RI Work Plan identifies the appropriate level of alternatives analyses and involves listing general response actions most applicable to the type of site under investigation. General response actions are broadly defined as those that may satisfy the objectives for remediation defined for OU8. Those objectives include the protection of human health and the environment from ingestion, dermal contact, or inhalation of contaminants that may be present in the surficial soils (and materials), vadose zone, saturated zone (groundwater), surface water and sediments, and air in the OU8 area through remediation. Table 4.1 provides a list and description of general response actions and typical technologies associated with remediating surficial soils (and materials), wastes, vadose zone, saturated zone, surface water and sediments, and air. Table 4.1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSS areas of OU8. Some will be rejected during the screening of alternatives.

The response actions outlined in Table 4.1 must be applied to the potential exposure pathways that will be identified for OU8. The response actions may provide control over all or some of the potential pathways. Partially-effective response actions can be combined to form complementary sets of response actions that control all pathways.

In general terms, potential human exposure may be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where contact with the released contaminant could be prevented.

While the identification of general response actions is discussed above, the selection of the most appropriate action or combination of actions is not warranted at this time. Site and contaminant data are not sufficient to initiate the remedial alternatives screening process. Phase I will generate data (Table 4.2) necessary to characterize the nature and extent of contamination and will evaluate the impact of OU8 on surface water, groundwater, air, the environment, and biota, in addition to characterizing potential contaminant migration pathways. Data obtained from these investigations will:

- Describe the physical characteristics of the site;
- Define sources of contamination;
- Determine the nature and extent of contamination in surficial soil (and materials), vadose zone, saturated zone (groundwater), surface water and sediments, and air;

- Describe contaminant fate and transport; and

- Describe receptors.

These data will provide information for the preliminary screening of alternatives and a thorough, comparative evaluation of the technologies with respect to implementability, effectiveness, and cost. This information will allow for informed decisions to be made with respect to the selection of preferred technologies. The FSP in Section 6.0 describes the methodology that will be followed to obtain the required information for the Phase I RFI\RI characterization.

4.7.2 Detailed Analysis of Remedial Alternatives

The detailed analysis of each alternative will be performed when sufficient data are generated. The detailed analysis and selection of alternatives is not a final decision-making process; rather, it is the process of analyzing and comparing relevant information in order to select a preferred remedial action. In accordance with the NCP, containment technologies will generally be appropriate remedies for wastes that pose a relatively low-level threat or where treatment is impracticable (EPA, 1991). Each appropriate alternative will be assessed in terms of nine evaluation criteria, and the assessments will be compared to identify the key attributes among the alternatives. Assessment based on the nine evaluation criteria is necessary for the Corrective Measure Study (CMS) and the subsequent Corrective Action Decision (CAD)/Record of Decision (ROD). The nine evaluation criteria are as follows:

1. Overall protection of human health and the environment;

2. ARARs;

3. Long-term effectiveness and permanence;

4. Reduction of toxicity, mobility, or volume;

5. Short-term effectiveness;

6 Implementability;

7 Cost;

8 State acceptance; and

9 Community acceptance.

These criteria are described in recently revised guidelines provided in the NCP. The first two criteria are considered threshold criteria because they must be evaluated before further consideration of the remaining criteria. The next five criteria are considered the primary balancing criteria (per NCP) on which the analysis is based. The final two criteria are modifying criteria to be addressed during the final decision-making process after completion of the CMS/FS.

4.8 TASK 8 - TREATABILITY STUDIES/PILOT TESTING

This task includes efforts to provide technical support in the form of bench scale and/or pilot-study treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or appropriate to support the OU8 RFI/RI. EG&G has prepared a site-wide Treatability Studies Plan which addresses this task. The treatability studies at OU1 and OU2, will be utilized as appropriate for OU8.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are generated during the development and screening of remedial alternatives and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU8 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Additionally, the technologies considered will be required to be readily implementable (i.e., standard design package units available) within a short time frame Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, it may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction; potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench-scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process, and the regeneration process can be performed at either off-site or on-site facilities.

Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants and requires further treatment or disposal.

Air Stripping - Air stripping is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated-carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds or to separate mixtures of organics into light and heavy fractions. The light fraction can usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

Biological Reactors - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

Sorption of Radionuclides - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbents are addressed separately elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater. More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site. In the same study, plutonium adsorption on bone char was the most rapid and gave the highest decontamination factors. Waste-stream-specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

Ion Exchange of Radionuclides - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent. A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as micrograms per liter. Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste.

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

In Situ Biological Treatment - Depending on the effective porosity of the soils, *in situ* biological treatment may be feasible. *In situ* biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. *In situ* treatment is dependent on geological and hydrological conditions. The process is relatively inexpensive.

Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an *in situ* treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing·

Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until it melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of inorganics, metals, and radionuclide contaminants. Organic components are destroyed by pyrolysis. The process can be conducted either *in situ* or off site; however, the process is generally expensive.

Physical Separation - Soil contaminants are often found to be associated with a particular size fraction of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be an effective means of reducing the volume of the material that requires further treatment. The processes used for soil-size fractionation include screening, classification, flotation, and gravity concentration.

Soil Washing - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organics, inorganics, metals, and radionuclides The wash solution containing the contaminants will require treatment and/or disposal

4 9 TASK 9 - RFI/RI REPORT

The OU8 RFI/RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail the field activities that serve as a basis for the RFI/RI report. This will include any deviations from the Work Plan that occurred during implementation of the field investigation.
- Discuss site physical conditions. This discussion will include surface features, meteorology, surface-water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.
- Present a Site Characterization based on all RFI/RI activities at OU8 and characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, surficial soils (and materials), vadose zone, saturated zone (groundwater), surface water and sediments, air, and biota.
- Present a baseline risk assessment which will include an evaluation of contaminant fate and transport. This discussion will include potential migration routes, contaminant persistence, chemical attenuation processes and potential receptors. The risk assessment will include human health and environmental evaluations.
- Present a summary of the findings and conclusions.
- Identify additional data needs, if necessary.

21/26

TABLE 4.1

GENERAL RESPONSE ACTIONS
TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES AND EVALUATION

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
No Action	No remedial action taken at site	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative Would not address potential pathways, although existing access restriction would continue to control onsite contact.
Access and Use Restrictions	Permanent prevention of entry into contaminated area of site Control of land use	Site security, fencing, deed use restrictions, and warning signs.	Could control onsite exposure and reduce potential for offsite exposure Site security fence and some signs are in place Additional short-term or long-term access restrictions would likely be part of most remedial actions
Containment	In-place actions taken to prevent migration of contaminants	Capping, groundwater containment barriers, soil stabilization, and enhanced vegetation	If applied to source, could be used to control all pathways If applied to transport media, could be used to mitigate past releases (except air)
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal	Groundwater pumping, leachate collection, and liquid removal from surface impoundments	Applicable to leachate removal prior to *in situ* treatment or waste removal Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums)
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, and contaminated structures.	If applied to source, could be used to control all pathways If applied to transport media, will control corresponding pathway Must be used with treatment or disposal response actions to be effective

TABLE 4.1 - Continued

GENERAL RESPONSE ACTIONS
TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES AND EVALUATION

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
In Situ Treatment	Application of technologies *in situ* to change the in-place physical or chemical characteristics of contaminated material	*In situ* vitrification and bioremediation	Applied to source, could be used to control all pathways Applied to transport media, could be used to control corresponding pathways
Treatment	Application of technology to change the physical or chemical characteristics of the contaminated material Applied to material that has been removed.	Solidification; biological, chemical, and physical treatment.	Applied to removed source material, could be used to control all pathways Applied to removed transport media, could control air, surface water, ground water, and sediment pathways
Storage	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal	Temporary storage structures	May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways
Disposal	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfills and repositories	With source removal, could be used to control all pathways With removal of contaminated transport media, could be used to control corresponding pathway (except air)
Monitoring	Short-and/or long-term monitoring is implemented to assess site conditions and contamination levels	Sediment, soil, surface water, and groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

TABLE 4.2

RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND DATA REQUIREMENTS

Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Complete or Partial Removal and Treatment of Contaminated Soils	Disposal (off-site)	Evaluate RCRA Land Bank and Radioactivity Restrictions	- 40 CFR 268 Table CCWE and Appendix III Analyses - Full Suite of Radionuclide Analyses
		Cost Analysis	- Vertical and Horizontal Extent of Contamination
In-Situ Contaminated Soil Treatment	Immobilization	Determine Viscosity of Grout Material	- Soil Grain Size Distribution (Sieve Analysis)
		Effectiveness	- Full Suite of Organic and Inorganic Analyses
	Soil Flushing	Effectiveness	- Full Suite of Organic and Inorganic Analyses - Soil Organic Matter Content - Soil Classification - Soil Permeability - Treatability Study
	Vapor Extraction	Effectiveness	- Full Suite of Organic and Inorganic Analyses - Subsurface Geological Characteristics - Depth to Groundwater - Soil Permeability - Treatability
	Vitrification	Cost Effectiveness	- Full Suite of Organic and Inorganic Analyses - Treatability Study

23/26

TABLE 4.2 - Continued

RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES AND DATA REQUIREMENTS

Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Groundwater Collection	Well Array/Subsurface Drains	Storativity (transient flow)	- Aquifer tests
Infiltration and Groundwater Containment Controls	Capping/Subsurface Barriers	Suitability of Off-Site Soil for Use	- Gradation (Sieve Analysis) - Atterberg Limits (Plasticity Tests) - Percent Moisture - Compaction (Proctor) - Permeability (Triaxial Permeability) - Strength (Triaxial or Direct Shear)
		Effectiveness	- Location of Subcropping Sandstones - Hydraulic Conductivity of Bedrock Materials
		Construction Feasibility	- Grade - Depth to Bedrock
In-Situ Groundwater Treatment/ Immobilization	Immobilization	Determine Viscosity of Grout Material	- Soil Grain Size Distribution (sieve analysis)
		Effectiveness	- Full Suite of Organic and Inorganic Analyses
	Aeration	Effectiveness	- Full Suite of Organic and Inorganic Analyses - Subsurface Geological Characteristics - Depth to Groundwater - Soil Permeability - Treatability Study

24/26

TABLE 4.2 - Continued

RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES AND DATA REQUIREMENTS

Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Groundwater/ Surface Water Treatment	UV/Peroxide or UV/Ozone	Process Control	- Iron and Manganese
		Effectiveness	- Full Suite of Organic and Inorganic Analyses - Treatability Study
	Air Stripping	Process Control	- Hardness
		Effectiveness	- Full Suite of Organic and Inorganic Analyses - Treatability Study
	Other Water Treatment Technologies (carbon adsorption, ion exchange, electrodialysis, and reverse osmosis)	Process Control	
		Effectiveness	
Footing Drain Exfiltration and Infiltration Controls and Discharge	Excavation	Construction	- Depth, Grade, Construction Materials - As-built Engineering Design - Dismantled or Altered Sections
	Capping	Effectiveness	- Location of Discharge Point(s) - Hydraulic Connection with Alluvial or Bedrock Materials - Current Construction Integrity

25/26

TABLE 4.2 - Continued

RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES AND DATA REQUIREMENTS

Response Actions	Associated Remedial Technologies	Data Purpose	Data Need
Footing Drains (continued)	Groundwater/Surface Water Treatment	See Above	- Same as Above
	Groundwater Collection	See Above	- Same as Above
	In-Situ Contaminated Soils Treatment	See Above	- Same as Above

Approved By

6/28/94 — Manager, Remediation Programs

6/28/94 — RFI Project Manager

5.0 DATA QUALITY OBJECTIVES AND DATA NEEDS

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are established to define data needs for each of the RFI/RI tasks, coordinate collection activities to support those needs, and to ensure the quality and quantity of resultant data. Collectively the data are used to make decisions regarding the risks the site poses to human health and the environment and to make decisions regarding which remedial measures are appropriate to mitigate the risks. DQOs are developed interactively with ongoing RFI/RI activities. The DQO development process is flexible, iterative, and dependant upon evaluation of existing data and data that become available as a result of RFI/RI activities. Three stages are used in the development of DQOs, and each of the steps is outlined below (EPA, 1987).

Step 1 - Identify Decision Types

- Identify and involve data users;
- Evaluate available data;
- Develop a conceptual model of the study site; and
- Specify RFI/RI objectives, and anticipate the decisions necessary to achieve the objectives.

Step 2 - Identify Data Uses and Needs

- Identify data uses;
- Identify data types;
- Identify data quality needs,
- Identify data quantity needs;
- Evaluate sampling and analysis options; and
- Review data precision, accuracy, representativeness, completeness, and comparability (PARCC).

Step 3 - Design Data Collection Program

- Assemble data collection components; and
- Develop data collection documentation.

The DQO elements are continually revised and reevaluated on the basis of new data developed during each phase of the RFI/RI. As the environmental characteristics and the nature of contamination of the study area become better understood, additional data requirements will become apparent, and both the DQOs and the FSP may evolve in response to these requirements. The following discussion addresses each of the DQO elements.

5.1.1 Step 1 Identification of Decision Types

5 1.1 1 Identification of Data Users

The following is a list of agencies and organizations that are the principal decision makers, program managers and technical personnel who will use the data that will be generated during the OU8 Phase I RFI/RI (ERP, 1991).

Principal Decision Makers:

- United States Department of Energy, Office of Environmental Restoration and Waste Management, Secretary of Energy, and the Acting Assistant Secretary for Environmental Restoration and Waste Management.

- United States Department of Energy, Rocky Flats Office.

- United States Environmental Protection Agency, Region VIII, Waste Management Division Director, Federal Facilities Branch Chief, and the Rocky Flats Remedial Project Manager.

- State of Colorado Department of Health, Hazardous Materials and Waste Management Division Director, Hazardous Waste Section Leader, Hazardous Waste Facilities Unit Leader, and the Monitoring and Enforcement Unit Leader.

Program Management:

- EG&G Rocky Flats Plant, Environmental Management Department, Associate General Manager for Environmental Restoration and Waste Management, Environmental Management Department Director, Environmental Management Department Division Managers, and matrix project personnel from other Rocky Flats Plant or external EG&G organizations.

- Natural Resources Trustees under CERCLA including DOE, CDH, Colorado Department of Natural Resources, Colorado Attorney General, and U.S. Department of the Interior.

Technical Personnel:

- EG&G Rocky Flats Plant technical specialists and subcontractors responsible for supervising, coordinating and performing Environmental Restoration activities.

5.1.1.2 Evaluation of Available Data

Existing data are described in Section 2.0 of this document. Soils and geologic data collection activities in the vicinity of OU8 have been primarily directed toward defining the RFP environmental setting. Much of the data were developed as a result of the RFP Geological Characterization including chemical data used to characterize the types and sources of contamination present in the soils and groundwater. The available soils and geology data were not developed for the specific purpose of characterizing OU8.

Existing ambient air monitoring programs characterize the Rocky Flats Plant site on an area-wide basis for total suspended particulates, PM_{10}, plutonium and americium. The Rocky Flats Plant site air monitoring stations are shown in Figures 1-29 and 1-31. These data are not specific to any of the OU8 IHSS sources but provide a baseline for the Rocky Flats Plant and are collected according to air sampling procedures specified in Environmental Management Division (EMD) Operating Procedures Manual No. 5-21000-OPS-AP, Volume VI, Air.

Surface-water and sediment chemistry data (metals, water quality, and radiochemistry) for OU8 are available from 26 sampling stations located in two drainage basins (Figure 1-12).

Data for surface water, groundwater, soils, and geology are in the process of being validated in accordance with Sections 3.4 and 3.7 of the Rocky Flats Plant Site-Wide Quality Assurance Project Plan. Some of the data are validated and accepted, some are validated with qualifications, some have been rejected and some have yet to go through the validation process. The Rocky Flats Environmental Database lists the available analytical data and identifies which samples have been validated.

5 1.1.3 Site Conceptual Model

Conceptual models of IHSSs in OU8 have been developed and are presented in Section 2.5 of this document. The models include a description of potential sources of contamination, release mechanisms, transport media, exposure routes, and potential receptors. The conceptual models were developed by organizing the IHSSs into three logical groups based upon the contaminant source types and release mechanisms. The three groups and the IHSSs that compose each group are listed below. IHSSs 150.1 and 150.4 are each listed in two groups because they each exhibit characteristics of more than one group.

- Leaks, spills, and overflows of tanks and pipelines originating below ground surface: 118.1, 123.1, 135, 137, 138, 144, 150.3, and 150.4.
- Releases associated with fires and explosions: 150.1, 150.2, and 150.7.
- Leaks, spills, and overflows of tanks, pipelines, and/or drums originating above ground surface: 118.2, 139.1, 139.2, 150.1, 150.4, 150.6, 150.8, 151, 163.1, 163.2, 172, 173, 184, and 188.

The conceptual models will be an aid in identifying exposure pathways and evaluating the potential risks to human health and the environment posed by the contamination present in OU8.

5.1 1.4 Data Objectives and Decisions

The DQO process requires that specific data objectives be defined; formulation of the objectives leads to the identification of data needs. The data objectives for the OU8 RFI/RI Work Plan are summarized in Table 5.1. Data needs are expected to evolve based upon new information generated as the Work Plan is implemented. From the information generated by the RFI/RI, decisions can be made regarding whether remediation is necessary and which remedial alternatives would be appropriate.

5.1.2 Step 2 - Identify Data Uses and Needs

5.1.2.1 Identify Data Uses

The principal uses of RFI/RI data have been defined in Data Quality Objectives for Remedial Response Activities and are listed below (EPA, 1987).

- **Site Characterization** - data are used to determine the nature and extent of contamination at a site;
- **Health and Safety** - data are used to establish the level of protection needed for on-site workers and to determine if there is imminent danger to the surrounding population;
- **Risk Assessment** - data are used to evaluate the threat posed by the site to public health and the environment;
- **Evaluation of Alternatives** - data are used to evaluate which remedial technologies may be appropriate;
- **Engineering Design of Alternatives** - data are used in the remedial design process to evaluate the performance of various remedial technologies;

- **Monitoring During Remedial Action** - after remedial actions are implemented, data are used to assess their effectiveness; and

Data uses specific to RFI/RI Phase I sampling and analysis activities for OU8 are listed in Table 5.1

5 1.2.2 Identify Data Types

Data types will consist of field survey and laboratory analytical results of samples for each RFI/RI objective (Table 5.1) The physical media to be sampled include air, soil, soil gas, surface water, asphalt/concrete, and groundwater. Radiation surveys will also be performed at selected IHSSs.

Exposure assessment modeling requires additional data types. Data necessary for air dispersion modeling generally include relative wind direction and frequency, atmospheric stability and wind speeds, ambient concentrations of airborne particulates, soil adsorption coefficients, solubility, particle size, and precipitation. Most of these parameters will be determined from RFP-wide atmospheric studies or from literature values. The OU8 Phase I field program will collect data pertaining to IHSS air pathways by coordinating existing individual monitor operation schedules and correlating the data to IHSS field activities and conditions.

5.1.2.3 Identify Data Quality Needs

Analytical methods and support levels must be evaluated during the DQO process. The parameters for which an analytical method is valid, its limitations, and any special considerations which will affect data quality must be understood in order to select appropriate methods. Table 5.1 lists the analytical levels appropriate for the intended data uses. The five levels of data quality as presented in EPA's Data Quality Objectives for Remedial Response Activities Development Process (EPA, 1987) are as follows:

- **Level I** Field portable instruments. Results are typically not compound-specific or quantitative. This analytical level is appropriate for providing real-time health and safety data and as a screening tool to indicate potentially contaminated areas.

- **Level II** Mobile laboratories and field gas chromatograph/mass spectrometer (GC/MS) units. Results may be compound-specific and quantitative depending on instrument calibration, reference standards, equipment condition, and operator capability. Real-time data may be available, or results may be produced in several hours. This analytical level is appropriate during the site characterization, evaluation of remedial alternatives, engineering design, and site monitoring.

- **Level III** Off-site analytical laboratory. Results generally have a greater degree of analytical precision than Level II. Data may be available in 24 hours or in several days to weeks. Level III is an appropriate level for some phases of site characterization, evaluation of remedial alternatives, engineering design, responsible party determination, and during site monitoring. Level III may be appropriate for risk assessment depending on the outcome of RFP policy decisions.

- **Level IV** EPA Contract Laboratory Program methods are required. The analytical precision is similar to that of Level III, but stringent quality assurance and quality control protocol are formally documented. Laboratory turn-around time for reporting analytical results are similar to those described for Level III.

- **Level V** Off-site analytical laboratory using non-standard methods. Analytical method development or modification is required, and analytical precision and reporting schedules may vary according to the method.

Analytical Levels I through V will be used during implementation of the OU8 RFI/RI. The analytical methods that will be used are those specified in the EG&G Rocky Flats General

Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B (EG&G, 1991b).

Potential contaminants have been identified by IHSS based upon the suspected or known contaminants released, toxicity, persistence in the environment, and frequency of occurrence. A general list of potential contaminants present is given in Table 5.2. This list is expected to evolve as additional data become available.

Levels of concern are based upon available health standards and are expressed as contaminant-specific concentration ranges or action levels. These concentration ranges serve as guidelines for selecting analytical methods, detection limits (as discussed below), and in determining the boundaries of field investigations.

Detection limit requirements take into account the levels of concern, RFP chemical-specific Benchmarks in lieu of ARARs, and DQOs specified in the RFP Site-Wide Quality Assistance Project Plan (EG&G, 1991a). Site-specific ARARs will be developed as the initial step in the OU8 corrective measures study. Detection limits are listed in Table 5.3.

5.1.2.4 Identify Data Quantity Needs

Data quantity needs are based on a review of the available environmental data and on the data uses previously described. Field sampling density is based on a subjective evaluation supported by statistical evaluation. The subjective evaluation includes review of details of release(s) to characterize the affected area or target size and site features to assist placement of sample locations where contamination is likely to be.

So that a sufficient quantity of data are collected, the FSP specifies a five stage approach to data collection The purpose of Stage 1 is essentially to gather sufficient logistical information to efficiently guide subsequent stages. The purpose of Stage 2 is to collect sufficient screening data to efficiently guide data collection in Stages 3, 4, and 5 Stages 3 and 4 should evaluate the extent of contamination, and the purpose of Stage 5 is to complete the collection of data needed for the RFI/RI investigation. Since the data quantity needed in Stage 3 is based on the results of Stage 2 and the data quantity needed in Stage 4 is based on the results of Stages 1, 2, and 3, etc., only Stage 2 data needs will be completely specified in this Work Plan. Section 6.0 contains a complete description of the investigation Stage 3 rationale and technical memoranda. The statistical approaches to sampling during Stages 2 and 3 are summarized below.

Stage 2

The FSP specifies the sampling density of each IHSS to be investigated during Stage 2. The statistical approach used to determine the sampling density and location is taken from a method developed by Gilbert (1987). This method allows for the determination of a sampling grid spacing dependent on a target contaminated area size and specified confidence. The Gilbert method assumes the following:

- The target area is circular or elliptical;
- Samples are collected on a square, rectangular, or triangular grid;
- The area between grid points is much larger than the actual area defined for sample collection and analysis sampled; and
- Definition of the contaminated area is clear and unambiguous.

The last assumption is difficult to meet at OU8 IHSSs because the size of the reported spills or releases is not known.

In addition to the assumptions listed above, the following considerations are also applicable In accordance with EPA guidance (EPA, 1990), the acceptable probability (β) of not finding the target contaminated area is specified as 0.1 or 10 percent. A triangular grid was chosen because studies have shown that triangular grids are less likely to fail to identify a given target than square grids (Gilbert, 1987). Based on the Gilbert methodology, triangular grids spaced approximately 24 ft are within acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 25 ft in size. Throughout OU8, the sizes of the smaller IHSSs are commonly less than 100 ft by 25 ft (less than 2,500 square feet), although spill areas within the IHSSs may be smaller. A triangular grid with samples spaced a maximum of 50 ft apart has shown an acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 199 ft in size (9,950 square feet). IHSSs considered to be large are those greater than 50 ft by 100 ft in size (5,000 square feet). However, potential anomalous areas within these may be smaller

Soil-gas and surficial soil sampling programs will be established on 25-ft triangular grids at most OU8 IHSSs that are less than 5,000 ft^2 in area For IHSSs larger than 5,000 ft^2 in area, soil-gas and surficial soil sampling will be performed on 50-ft triangular grids.

HPGe radiation surveys will be conducted on a 150-ft triangular grid spacing, or utilizing 30-ft grid for the tripod-mounted detector. NaI probe locations are planned at 15-ft grid spacing or less

Screening data will be assembled and summary statistics (including coefficient of variation and power) calculated for each IHSS and each parameter. Should the computed power fail to meet the requirements for the risk assessment, additional samples will be collected and analyzed. The number of additional samples to be collected will be determined using calculations provided in EPA guidance (EPA, 1990)

The additional samples will be located using geostatistical techniques Unlike classical statistics which assume independence of samples, geostatistics assumes that the data are spatially correlated. Using this analytic approach, the mean concentration and variance of the mean can be estimated at any given location in the contaminated area, and decisions concerning where additional samples should be collected can be objectively made.

As a first step in locating any additional samples, the spatial interdependence of samples in two dimensions will be expressed through the development of calculated, and then modeled semivariograms. The semivariograms will provide a measurement of the uncertainty that exists when a sample concentration is used to estimate the concentration of a contaminant in soil in the surrounding area.

Second, mean concentrations will be estimated across the contaminated area with the geostatistical method referred to as kriging. Kriging uses the information from the semivariogram to find an optimal set of weights that allow estimation of concentrations at unsampled locations. The kriged estimates will be displayed in the form of a contour map showing sampled and estimated concentrations throughout the IHSSs.

<u>Stages 3, 4, and 5</u>

The statistical approach to FSP Stage 3 planning will include a classical variability analysis of analyte concentrations using data collected during Stage 2. Because classical rather than geostatistical methods will be used, the number of samples required is unrelated to the size of the site. When Stage 1 research and Stage 2 sampling results are evaluated, geostatistical methods may be shown to be more appropriate for determining whether the data are adequate. The calculation of data needs for assessing variability will be performed as follows (Gilbert, 1987):

The prescribed margin of error and the acceptable error of estimation of the mean must be identified. The number of polygons to be sampled to estimate the population mean is a function of (1) the absolute margin of error that can be tolerated and (2) the acceptable confidence limits.

The basic equation for estimating the number of samples is the following:

$$n = (t_{1-\alpha/2,n-1}\ \sigma/d)^2$$

where:

n	=	number of samples required
$n-1$	=	degrees of freedom
$\sigma = S$	=	sample standard deviation
d	=	margin of error
$\alpha/2$	=	one-sided confidence limit
$t_{1-\alpha/2,n-1}$	=	$(1-\alpha/2)$ quantile of the t distribution with n-1 degrees of freedom

Although a reliable value of σ is not available for determining n, an estimate of the relative standard deviation $\eta = \sigma/\mu$ (the coefficient of variation), may be roughly estimated. Because this quantity is usually less variable from one study site to another than the mean (μ), the approach suggested is to specify the relative error (d_r) as $d_r = |x - \mu|/\mu$ such that:

$$\text{Prob}\,[\,|x - \mu| > d_r\mu] = \alpha$$

Therefore, the above equation becomes

$$n = (t_{1-\alpha/2,n-1}\ \eta/d_r)^2$$

where η must be pre-specified.

For risk assessment, a reasonable bound on the error of estimation is 0.2 of the mean (i.e., the 95 percent confidence interval around the mean is the mean plus or minus 20 percent of the mean) This level of uncertainty is small relative to the uncertainty associated with toxicological parameters used to estimate risk.

The first η can be assumed. For example, if η were assumed to be 0.59, which is common or relatively conservative in most soil sample data analysis, then, because $t_{1-\alpha/2,n-1}$ depends on n, an iterative procedure may be used. Using this approach, a sample size of 25 polygons is estimated as follows:

$$n = [1.708\ (0.59/0.2)]^2$$

$$n = 25$$

where the Student T variate is 1.708 and the confidence limit is 0 05 for one-sided and for 24 degrees of freedom.

Because the number of samples is fully dependent on the estimated value of the coefficient of variation, the sample number 25 can be expected to result in a mean calculation within the 95 percentage confidence limit only for a coefficient of variation less than 0.59. If the actual coefficient of variation is higher than 0.59, the number of samples would have to be increased. The preliminary estimate of 25 samples is also a prudent choice based on the Central Limit Theorem. Many statisticians recommend that this theorem can be safely applied if n is at least

25 or 30 The mean values calculated from subsets of populations of this approximate size tend to be normally distributed, even if the sample populations are non-normal.

Two performance measures that are commonly used to evaluate statistical sampling designs, such as the one presented here, are confidence level (α) and power (β) which are related to sample variability. The confidence level can be used to determine the probability of a false positive or Type I error The power can be used to determine the probability of a false negative or Type II error. For risk assessment purposes, EPA recommends a minimum confidence of 80 percent (Type I error = 20 percent) and a minimum power of 90 percent (Type II error = 10 percent) (EPA, 1990). The confidence level to be used for this statistical analysis is 95 percent and the power is not considered. A 95 percent confidence level provides a reasonable compromise between the probability of Type I and Type II errors.

Once the number of samples is determined, the site is divided into 25 segments of equal size, and one sample is taken systematically within each block. This systematic sampling plan provides more uniform coverage of a site than simple random sampling.

Sampling variability affects the degree of confidence the risk assessor can expect. Large variation of a contaminant in a medium indicates that the number of samples should be increased or that the samples of that medium should be stratified to reduce variability. An estimate of the sampling variability that is a function of the spatial variation of the concentrations of chemicals of potential concern is obtained by calculating the coefficient of variation, η, for each chemical (EPA, 1990) The coefficient of variation for Stage 3 will be estimated for sampling and analyses during Stages 1 and 2.

5.1.2.5 Evaluate Sampling/Analysis Options

The Phase I RFI/RI for OU8 will consist of a staged approach in which the results of analytical Level I and II field screening and soil sample collection and analysis are evaluated and used to focus subsequent Level III, IV, and V data collection and analysis in later stages. This approach will be used to ensure that sample locations and depth result in a representative set of data to characterize the site. The reevaluation of the data at each stage will also allow quantitative DQOs to be reviewed and planned for during the investigation to ensure that the data are statistically adequate for the intended uses.

This approach maximizes cost effectiveness through the development of logical sampling schemes. It minimizes the volume of generated hazardous waste material that requires special management, and the potential exposure of field personnel to hazardous waste material. Technical memoranda are planned at each stage to report results and present recommendations for any further sampling.

The sampling/analysis options selected are based upon their ability to obtain data that is consistent with known site history and current conditions. The actual sampling that is performed during the five Phase I stages will be IHSS specific. However, these stages may include the following types of sampling:

- Stage 1 - Building underdrain plan review and visual site inspection, sanitary and storm sewer systems inspection and information review, and surface-water and sediment sampling as needed to evaluate conditions within storm sewer and/or sanitary sewer systems;
- Stage 2 - HPGe, NaI probe, and alpha scanner radioactivity surveys, soil-gas survey, surficial soil sampling, vertical soil profiles, tank and pipeline inspections, and surface-water and sediment sampling,

- Stage 3 - Additional surficial materials sampling (soil, asphalt, and concrete) to further characterize nature and extent of contaminants determined during in Stages 1 and 2, soil borings and BAT® or equivalent sampling;

- Stage 4 - Additional soil borings and BAT® or equivalent sampling, leachability testing, soil tensiometer nest installation and piezometer installation; and

- Stage 5 - Groundwater monitoring well installation (as warranted).

Analytical Level I and Level II field screening will assess both radiochemical and organic chemical contamination during stage one of the FSP. Radiological surveys using a High Purity Germanium detector (HPGe) will be conducted to identify areas of radiochemical contamination that may require further investigation. Field methods for use of the HPGe are presently being finalized and a standard operating procedure will be incorporated in the Environmental Management Radiological Guidelines Manual (EG&G, 1991e). Soil-gas surveys utilizing a portable GC will be used to identify areas of organic chemical contamination and to direct further sampling efforts. Data collection procedures will be those specified in Environmental Management Division Manual 5-21000, Volume III, Geotechnical (EG&G, 1992d). Photoionization detectors will be employed for health and safety purposes.

5.1.3 Step 3 - Design Data Collection Program

Step three of the DQO process compiles the various elements of Steps 1 and 2 into a cohesive data collection program for the OU8 RFI/RI. To this end, a Field Sampling Plan and Quality Assurance/Quality Control Plan have been developed and are included as Sections 6.0 and 10.0, respectively, of this Work Plan.

18/26

Table 5.1

Phase I RFI/RI Analytical Data Quality Objectives

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Establish the presence or absence of contaminants	Soil-gas, HPGe, NaI, surficial soil (and materials), surface water, sediments, vadose zone, and groundwater data	For specified IHSSs, conduct radiation survey, soil gas survey, collect surface soil samples, subsurface soil samples, groundwater samples, and asphalt/concrete samples, as necessary	I for NaI, I and II for radiation survey, III for soil gas, IV for conventional analytes, & V for radiological analytes	• Contaminant source and multi-media characterization
Characterize the environmental setting of each IHSS				
Subsurface stratigraphy and characteristics of subsurface materials	Geologic description	Evaluate applicability of existing data from adjoining IHSSs, drill boreholes and log subsurface materials, collect soil samples for TOC, pH, grain size distribution, bulk density, and soil moisture content	I	• Soil and Subsurface Characterization
Depth to groundwater	Water level data	Water level data from existing wells, piezometers and newly installed boreholes and/or piezometers	I	• Subsurface Characterization
Groundwater flow regime	Water level data and aquifer tests	Evaluate applicability of newly developed aquifer data from adjoining Operable Units	I	• Aquifer Characterization
Vadose water flow regime	Soil moisture data and matric potential measurements	Evaluate applicability of newly developed vadose zone data from STP vadose characterization and the OU2 vadose study	I	• Vadose Zone Characterization

Table 5.1 - continued

Phase I RFI/RI Analytical Data Quality Objectives

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
Characterize the nature and extent of contamination				
Affected media including location, concentration, type, physical state, and quantity of contaminants	Surficial soils (and materials), surface water, sediments, vadose zone, and groundwater	For specified IHSSs, collect surface soil samples, subsurface soil samples, groundwater samples, and asphalt/concrete samples, as necessary	IV for conventional analytes and V for radiological analytes	• Site Characterization • Evaluation of Remedial Alternatives • Risk Assessment
Assess fate and transport of contaminants	Surface water, sediment, soil, and aquifer physical parameters	Evaluate applicability of newly developed aquifer data from adjoining Operable Units and vadose zone data from STP vadose characterization and the OU2 vadose study, collect soil and sediment samples for leachability testing, collect data from newly installed soil tensiometer nests, evaluate surface water and groundwater quality conditions from surface water sampling stations and newly-installed groundwater wells	I - III	• Risk Assessment
Assess risk to human health and environment	Data types indicated above	Synthesis of RFI/RI data	V	• Risk Assessment
Identify applicable remedial measures	Data types indicated above	Synthesis of RFI/RI data	II - V	• Evaluation of Remedial Alternatives

19/26

Table 5.2

POTENTIAL CONTAMINANTS PRESENT IN OU8

IHSS Number	Potential Contaminants Present
118 1	carbon tetrachloride
118 2	carbon tetrachloride, petroleum distillates, benzene, dichloromethane paint thinner, 1,1,1-TCA, MEK
123 1	uranium, solvents, oils, beryllium, nitric acid, hydrochloric acid, fluoride
135	chromate, phosphate, tritium
137	chromate, phosphate
138	chromium, gross alpha, phosphate
139 1	sodium hydroxide, potassium hydroxide
139.2	hydrofluoric acid, nitric acid
144	unspecified volatile organics, semi-volatile organics, metals, radionuclides
150 1	unspecified radionuclides, americium, plutonium, nitric acid, organic chemicals
150 2	plutonium
150 3	plutonium, other unspecified radionuclides, metals, organic chemicals
150 4	process waste water containing unspecified radionuclides, metals, unspecified volatile organic compounds
150 6	waste oil, unspecified radionuclides
150 7	plutonium
150 8	waste oil, unspecified radionuclides
151	No 2 Diesel oil, unspecified organic compounds
163 1	unspecified radionuclides, unspecified organics, inorganics, nitric acid
163.2	americium, plutonium
172	plutonium, hydraulic oil, carbon tetrachloride
173	plutonium, uranium, beryllium, acetone, solvents
184	unspecified radionuclides
188	nitric acid, hydrochloric acid, unspecified heavy metals

21/26

Table 5.3

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU8

TARGET COMPOUND LIST VOLATILES

	Water Limits (ug/L)	Soil Limits (ug/Kg)
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (total)	5	5
Chloroform	5	5
1,2-Dichloroethane	1	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
trans-1,2-Dichloropropene	5	5
Bromoform	5	5
4-Methyl-2-pentanone	10	10
2-Hexanone	10	10
Tetracholoroethene	5	5
Toluene	5	5
1,1,2,2-Tetrachloroethane	5	5

Detection limits are identified in the QAPjP
EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise

22/26

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU8

TARGET COMPOUND LIST VOLATILES - continued

	Water Limits (ug/L)	Soil Limits (ug/Kg)
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Xylenes (total)	5	5

TARGET COMPOUND LIST SEMI-VOLATILES

	Water Limits (ug/L)	Soil Limits (ug/Kg)
Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1-3-Dichlorobenzene	10	330
1-4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1-2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-Dipropylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol	10	330

Detection limits are identified in the QAPjP
EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise

23/26

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU8

TARGET COMPOUND LIST SEMI-VOLATILES, continued

	Water Limits (ug/L)	Soil Limits (ug/Kg)
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphtalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitrophenol	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphtalate	10	330
4-Chlorophenol Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine(1)	10	330
4-Bromophenyl-Phenyl ether	10	330
Phenanthrene	10	330

Detection limits are identified in the QAPjP
EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise

24/26

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU8

TARGET COMPOUND LIST SEMI-VOLATILES - continued

	Water Limits (ug/L)	Soil Limits (ug/Kg)
Anthracene	10	330
Di-n-butylphtalate	10	330
Flouranthene	10	330
Pyrene	10	330
Butyl Benzlyphthalate	10	330
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis-(2-ethylhexyl)phthalate	10	330
Di-n-octyl Phthalate	10	330
Benzo(b)flouranthene	10	330
Benzo(k)flouranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

Detection limits are identified in the QAPjP
EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise

25/26

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU8

TARGET ANALYTE LIST METALS

	Water Limits (ug/L)	Soil Limits (mg/Kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1
Cadmium	5	1
Calcium	5000	2000
Chromium	10	2
Cobalt	50	10
Copper	25	5
Cyanide	5	10
Iron	100	20
Lead	3	1
Magnesium	5000	2000
Manganese	15	3
Mercury	.2	2
Nickel	40	8
Potassium	5000	2000
Selenium	5	1
Silver	10	2
Sodium	10	2
Thallium	10	2
Vanadium	50	10
Zinc	20	4
Lithium	100	20

Detection limits are identified in the QAPjP
EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise

26/26

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS FOR SAMPLING ACTIVITIES AT OU8

SOIL GAS SAMPLES

Parameter	Detection Limit (ug/l)
Acetone	1
Benzene	1
Carbon disulfide	1
Carbon tetrachloride	1
Chloroform	1
Dichloromethane	1
Ethylbenzene	1
Methylene chloride	1
PCE	1
TCE	1
Toluene	1
Xylenes (total)	1
1,1-DCA	1
1,1,1-TCA	1
1,2-DCA	1
2-Butanone	1

Note Detection limits are a function of the detector type and injection volume Thus, the detection limit may vary Target detection limits will be at or below the listed values.

Approved by:

Manager, Remediation Programs 6/28/94 RFI Project Manager 6/28/94

6.0 FIELD SAMPLING PLAN

The purpose of this section of the work plan is to provide a field sampling plan (FSP) that will generate sufficient data to satisfy the RFI/RI objectives outlined in Section 5.0. Section 6.1 presents RFI/RI objectives. Section 6.2 summarizes the rationale for the sampling and analysis and other data collection activities. Section 6.3 discusses the standard operating procedures to be used for field activities. Section 6.4 describes field sampling methods and staged activities and Section 6.5 describes the sampling location and frequency. Descriptions of the air sampling program (Section 6.6), the Phase I RFI/RI report (Section 6.7), sample collection and analysis (Section 6.8), data management and procedures (Section 6.9), and quality assurance/quality control procedures and addendum (Section 6.10) complete the FSP for OU8.

6.1 PHASE I RFI/RI OBJECTIVE

This FSP provides the rationale and methodology for performing the Phase I RFI/RI at IHSSs located within OU8 at the RFP. The RFI/RI will address 24 separate IHSSs which have been identified as potential or confirmed contaminant sources in the IAG.

The general objectives of the Phase I RFI/RI are to characterize the nature and extent of contamination, to provide the data needed to support a risk assessment, and to aid in the selection of remedial alternatives. Specific objectives of the OU8 RFI/RI are to:

- Confirm or refute historical information and to accurately locate and describe release mechanisms and contaminants at each of the IHSSs;
- Define the nature of contamination at each of the IHSSs,

- Define the lateral and vertical extent of contamination at each IHSS,
- Supplement and refine the existing body of knowledge regarding the environmental characteristics of the IHSSs including transport mechanisms,
- Evaluate potential risks posed to the public health and the environment; and
- Develop sufficient data regarding the conditions at the IHSSs and nature and extent of contaminants present to enable evaluation and selection of remedial alternatives and provide information on the nature, extent, and level of contamination present at each IHSS to support development and evaluation of cleanup options and technologies in a Feasibility Study/Corrective Measures Study (FS/CMS)

This FSP was developed primarily based on the history of releases and process knowledge, and developed with the data quality objectives (DQOs) set forth in this Work Plan, and will be capable of providing quality data that are compatible with other RFP investigations using the same standard methods specified in this Work Plan.

6.2 SAMPLING RATIONALE

The design of a FSP for determining nature and extent of contamination requires an understanding of both the physical characteristics of the IHSSs and the nature of potential sources of contamination. OU8 consists of 24 separate IHSSs. The nature of contamination at most of the OU8 sites is not specifically known No data have been previously collected at OU8 IHSSs. Historical information presented in the Historical Release Report (HRR)(DOE, 1992a) provides general indications of the types of compounds that may be anticipated at the sites. In all cases, there is no documentation of the HRR which details the fate of any constituents released to the environment. Soils contamination could have resulted from historical spills, releases to the air, storage of material, or ponding of liquids at most of these sites. Asphalt paving, concrete, or soil regrading has occurred after many of the historically reported incidents, removing visible evidence of spills or possible releases

Given the variable nature of the sites and their relatively brief histories, sampling programs have to be designed to be IHSS-specific. In general, the multi-task sampling approach described below will be used for determining the potential source locations and extent of contamination. The tasks are designed to provide data to refine subsequent tasks and include the following in order of occurrence.

- radiation survey of surface and shallow subsurface soils and asphalt including vertical profile soil sampling;
- surficial soil sampling for radionuclides and nonradionuclides,
- chemical contamination screening of soil-gas, subsurface soils, and groundwater;
- determination of the groundwater hydraulic gradient using piezometers;
- installation of soil borings based on earlier surveys;
- vadose zone monitoring and collection of appropriate geotechnical and geochemical data to determine physical and chemical characteristics of contaminated media; and
- installation of groundwater monitoring wells to assess the nature and extent of groundwater contamination based on earlier studies

This approach has been developed to allow for a systematic investigation of potentially contaminated media at each IHSS and at OU8 as a whole. In the event that the radiation survey, surficial soil and sediment sampling, and soil-gas indicates that no contamination is present at a sampling location, then soil borings and monitor wells may not be installed. Conversely, if contamination is detected during the performance of any of the tasks listed above, additional tasks will be conducted until the extent of contamination has been fully characterized.

Environmental samples will be collected to achieve the data objectives (Section 5.0) stated in this Work Plan. Sampling activities will be staged, allowing the initial stages to provide information that can be used to direct and refine the methods used in subsequent stages. At critical points in the Phase I RFI/RI investigation, a technical memoranda will be prepared to summarize and present the interpretation of the information that was collected previously Based upon an evaluation of the acquired data, the technical memoranda will outline approaches for continued investigations. Where warranted, the memoranda will recommend changes in the investigation scope, variance in subsequent staged investigations, and will include any rationale and changes to the FSP regarding sample frequency, location, procedures and methodology, and analysis parameters TMs will also provide FSPs for Stages 3 through 5.

The rationale used to select the analytes of concern specified in Section 5 of this Work Plan took into account the following considerations:

- The operating history of the IHSS suggests that there is a strong probability that the contaminant was released into the environment;
- The physical and chemical properties of the contaminant suggest that it is persistent once it has been released into the environment;
- The principal analytes of concern at each IHSS are identified in Attachment 2, Table 5 and Attachment 4 of the IAG (Appendix A), Section 2.4 and are discussed in the HRR (DOE, 1992a and 1992b) including recent updates completed by Doty and Associates (Appendix B);
- RFEDS analytical data that are applicable to OU8 indicate the presence of the contaminant in quantities above the maximum background concentration for RFP

Coordination of field sampling activities between contiguous Operable Units will be done to conserve resources and minimize field mobilization costs. Such coordination will permit efficient and thorough evaluation of current conditions and the nature and extent of contamination for each IHSS in OU8.

6 2 1 Surficial Soil and Other Materials

The rationale for surficial soils sampling is based on a lack of data which would indicate whether contamination of the soils and surficial materials (e.g asphalt/concrete) from particular IHSSs has occurred, and/or would indicate the nature and extent of said contamination

Within OU8 there are several IHSSs in which contamination of the surficial materials may have occurred. This assumption is based on the volume of the release, response to said release and the chemical character of the contaminant, including the potential for buffering or the likelihood that the contaminant would still be present in significant amounts Insufficient data due to the lack of validation of the current data and/or absence of analyses does not allow an adequate characterization of the individual IHSSs. In addition, variable geologic conditions and physical barriers (e.g pavement over an IHSS that post-dates the releases) exist at OU8 within the surficial materials and shallow bedrock which may complicate the expected flow paths of potential contaminants

Surficial materials sampling can establish the presence, nature, and extent of contaminants. It is likely that in most cases surficial materials sampling will also be able to determine the source areas, except in some areas with overlapping source areas. Additional data regarding the geochemical and physical characterization of the surficial materials at OU8 is needed, and a preliminary step towards this goal will be accomplished by implementing the surface soil sampling plan as set forth in this section. This goal will also be accomplished by investigating surficial materials for radionuclide contamination using a sodium-iodide scintillation probe, HPGe detector and vertical soil profiles; and collecting surficial soil samples for analyses of TAL metals, semi-volatile organic compounds (SVOCs) and other contaminants that may have been released at specific IHSSs.

6.2.2 Surface Water and Sediment

The contaminants released to the environment from the IHSSs were often spilled or placed onto uncovered ground or on parking lot surfaces which would allow infiltration and run-off of incident precipitation and the transport of the constituents into the drainageways downstream of the IHSSs. Also, water-transport of contaminated soils or other surface materials into ditches and stream courses is expected to result in the occurrence and deposition of contaminated stream sediments The location of the existing surface water and sediment monitoring sites are in areas that collect run-off from large land areas of varied uses and development including numerous IHSSs and other operable units within the RFP Information continues to be collected by existing site-wide surface-water and sediment collection programs at Rocky Flats Analytical information from these programs will be continually updated for OU8, and if additional sampling is identified to isolate run-off from individual contamination sources, then close coordination with these programs will be performed to reduce redundant sampling efforts

Many of the buildings within the OU8 boundary have perimeter footing underdrains. It is suspected that groundwater in the vicinity of these underdrains is being collected and discharged into the storm sewer (or sanitary sewer) systems and then being discharged into the open drainageways. Identification of the underdrains and the location of the surface discharge points is necessary to determine the interaction between the groundwater and surface water within OU8.

A staged approach to surface-water and sediment monitoring is recommended within this section This approach would analyze existing data, collect additional data where needed, and analyze that data before making further decisions regarding the continuation of field sampling.

6 2.3 Vadose Zone

Existing groundwater data for the wells in the vicinity of OU8 IHSSs are described on an IHSS-specific basis in Section 2 4 None of the existing wells were installed for the purpose of monitoring the vadose zone Therefore, information on conditions in the vadose zone in the vicinity of the IHSSs is lacking and indications of contamination are limited to analysis of borehole samples (soil and groundwater) collected during drilling operations. Other methods to investigate the vadose zone during the implementation of the work plan would include soil-gas surveys, installation of soil tensiometer nests, and installation of additional soil borings. Soil samples collected during soil boring drilling will be collected to obtain geochemical and geophysical data and run to leachability tests on. The soil borings would also be used to collect groundwater samples via a BAT® sampler or equivalent (see the following section) A Field Sampling Plan for vadose zone work would be provided in the appropriate technical memoranda, if required, based on results collected to date

6.2.4 Groundwater

Within OU8 there are several IHSSs in which contamination of the groundwater may have occurred This is based on the volume of the release, suspected pathway, and the chemical character of the contaminant, including the potential for dilution or the likelihood that the contaminant would still be present in significant amounts. Insufficient data due to the absence of downgradient groundwater monitoring wells do not permit an adequate characterization for delineation of the nature and extent of contamination at individual IHSSs. In addition, variable geological structural conditions exist at OU8 within surficial materials and shallow bedrock which may complicate the expected flow paths of potential contaminants, especially the presence of footings drains and outcropping and subcropping Arapahoe sandstones The presence of surface drainages and footing drains in the vicinity and under various IHSSs could act as a pathway for contaminants to leave the groundwater system through infiltration along the walls of stream valleys and former excavations

Groundwater sampling will establish the presence or absence, and to some degree the extent of a contaminant. However, it may have limited use in establishing sources, especially in an area with overlapping IHSSs, unless the hydrogeological conditions are well understood or are adequately represented in a conceptual model. Additional data regarding the geochemical and physical characterization of the groundwater system at OU8 is needed and a preliminary step towards this goal can be accomplished by implementing the sampling plan for groundwater as described in Section 6 4.

The rationale for groundwater sampling, utilizing a BAT® sampler or equivalent in soil borings drilled into the saturated zone, is based on a lack of groundwater monitoring well data which would indicate whether contamination of the groundwater exists or is sourced at a particular IHSS The BAT® samples will provide a preliminary assessment of the hydrochemistry and may point to the need for additional groundwater investigation (i.e., installation of monitoring wells) To provide supplemental information concerning hydraulic gradient and the subsurface flow regime, piezometers would also be installed.

6.2.5 Rationale for Specifying and Collecting Additional Air Quality Data

Whether defining baseline conditions or monitoring field operations, monitoring is the primary approach used to characterize and verify area air emissions. Air monitoring technologies can be organized into the following four generic categories:

1 Direct Emissions Measurement - This method is preferred for investigating an area's volatile soil gases Area emissions measurement generally involves isolating a small section of soil surface with an airtight enclosure and measuring

the concentration of vapor resulting in the headspace Alternatively, soil-gas plume boundaries and concentrations can be quickly defined by inserting an extraction probe into site soils and analyzing collected soil gases These concentration measurements can be used to calculate an emission flux, which can then be related to an emissions rate for the area source. Although neither method considers local meteorological influences other than at the time of sampling, the acquired data can be used to develop estimates of volatile organic emissions to air Neither technique allows evaluation of particulate emissions to air.

2. Indirect Emission Measurement - This method involves measuring the atmospheric concentration of the emitted species (volatile and/or particulate matter) and equating this data to an estimated emission rate. All techniques involve clusters of ambient air samplers positioned close to the emission source Precise monitoring schemes require individual monitors be placed in a vertical array at each monitoring station. Screening measurements can be made upwind, downwind, and/or directly above the site using real-time instruments. Downwind measurements can be corrected for instrument bias and upwind interferences. False negatives may occur if species concentrations are below instrument minimum detection levels. These methods are appropriate for assessment of airborne total suspended particulate/respiratory particulate concentrations

3. Air Monitoring/Modeling - With this method of monitoring, technologies that measure ambient air concentration are combined with air dispersion algorithms to calculate the area source emission rate. These models usually provide air concentration information at a distance further downwind than indirect measurement data, and they do not distinguish between multiple units within a combined site.

4 Predictive Emissions Models - With this method, emission rates for a wide variety of waste types can be predicted provided fairly detailed information is available for model input. Assumptions concerning the theoretical and empirical relationships of individual contaminant mobility are applied to known site-specific factors to derive estimates of individual contaminant emissions rates These rates are then added to determine the overall emission rate from the site

Information currently available for OU8 does not support an air pathway assessment for IHSS at OU8 These limited data preclude the application of predictive emissions models in estimating individual site emissions rates. Similarly, dispersion modeling methodologies do not lend themselves to IHSS air pathway analysis However, the existing Radioactive Ambient Air Monitoring Program (RAAMP) monitoring can continue to be used in the acquisition of airborne particulate information on multiple RFP units, including OU8 IHSSs

Data from existing high-volume samplers will be evaluated for application at OU8 because they provide a high particulate loading on the filters. Heavily-loaded filters provide greater deductibility than lightly-loaded filters Filters in the low-volume total suspended particulate samplers are often so lightly loaded that concentrations of many radionuclides fall below detection limits. The high-volume samplers collect almost twice as large a volume of air in 24 hours (2448 m3). The high-volume filters, therefore, should have more contaminant mass and better deductibility than the low-volume filters. Additionally, EPA guidelines specify that total suspended particulate should be sampled with a high-volume sampler (EPA, 1985) for analysis of inorganic compounds

6 3 INTEGRATION WITH RFP STANDARD OPERATING PROCEDURES

EG&G Rocky Flats Plant Environmental Management has established SOPs for the performance of a wide variety of RFI/RI related tasks To ensure quality and uniformity in the execution of the OU8 Work Plan, the Work Plan specifies SOPs that are to be employed for each sampling task Table 6.1 summarizes SOPs to be used during Stages 2 and 3 of the FSP, and Table 10 1 summarizes all SOPs to be followed Each IHSS may have unique conditions that require modification of an SOP; modifications will be requested by a Document Change Notice (DCN) and when possible will be included in the appropriate Technical Memorandum (TM). Those activities that generate appreciable quantities of particulate will be conducted in accordance with the Rocky Flats Plan for Prevention of Contaminant Dispersion (PPCD)

6 4 SAMPLING METHODS AND STAGED ACTIVITIES

The primary goal of the OU8 Phase I FSP is to collect the data necessary to fulfill the Phase I Work Plan objectives outlined in Section 5.0 (DQO's) and Section 6 1.

The FSP is DQO based. This document spells out in detail the minimum Phase I sampling and field work requirements for each of the OU8 IHSSs. These requirements were based upon available information about the IHSSs at the time the IAG was finalized. In the course of researching this Work Plan, additional data have become available (Appendix B) which warrant modifying the scope and/or method of field investigation for a number of OU8 IHSSs. The field work proposed in this FSP for any particular IHSS may therefore vary from that stipulated in the IAG

It is recognized that the FSP must remain flexible in order to accommodate RFP operations and security requirements, utilities, interferences, and similar variables Subsequent stages of the FSP must also allow for adjustment to the data obtained in earlier stages, for instance, final borehole locations cannot reasonably be selected before the results of field screening surveys are interpreted

All FSP work will be conducted based on the Stage 1 activities and Stage 2 field screening results, statistical analysis of those results (as presented in Section 5.0), DQOs, and EG&G Rocky Flats Plant SOPs. These documents provide specifications for sample collection, handling, and analytical protocol The SOPs and Health and Safety (H&S) guidance documents will be of particular importance in implementing the Phase I RFI/RI activities.

Appropriate field sampling and decontamination procedures for the OU8 RFI/RI field investigation will be in accordance with the most recent version of the RFP Environmental Management Division Operating Procedures (EMD SOPs) (EG&G, 1991m) dated March 1, 1992. Appropriate EMD SOPs are referenced in the following sections The EMD SOPs are supplemented by EPA procedures (EPA, 1989b) and American Society of Testing Materials (ASTM) standard (ASTM, 1991) EMD SOPs are currently in development for some of the procedures within this plan.

The following subsections describe the sampling techniques that will be used during implementation of the FSP Any one or all of the following sampling techniques, where appropriate, will be continued to the edge of any possible contamination anomaly, or until another IHSS boundary is encountered

6.4.1 Stage 1 Activities

Stage 1 will address the logistics of FSP implementation prior to the commencement of field work. Detailed coordination with several RFP departments will be necessary. A Health and Safety Plan will be prepared with input from RFP health and safety personnel and from the EG&G Radiological Engineering Group Because most of the OU8 IHSSs are within sensitive areas, coordination with RFP security will be of particular importance Facility operations personnel will be apprised of planned activities and schedules so that interference with RFP operations is minimized. Drilling permits, RFP excavations permits, and other required permits will be obtained Qualified drilling, excavation, and other necessary subcontractors will be used

Additionally, dynamic documents such as the HRR, that may have changed subsequent to the release of this document, or other documents providing updated data on OU8 that may be published after this document, will need to be reviewed prior to the implementation of this Work Plan. A site visit and/or personnel interviews may be necessary to acquire information pertaining to the current state of some individual IHSSs (e g., the existence and/or location of an underground storage tank, etc.). Also, evaluation of the site-wide air monitoring program will be done to determine location and frequency of air monitoring sites.

6 4.1 1 Underdrains

It is anticipated that groundwater is being collected and transported in underdrain systems located around the perimeter of foundation footings of some buildings An analysis of this situation will require additional information regarding the existence of perimeter footing underdrains. It is unknown if each building within OU8 actually has a perimeter footing underdrain system in place, whether it is connected with other drains, what its constructed depth is, and where the discharge point is located Available plant plans will be reviewed for design and construction information. Following review of as-built drawings, a site walk of the facilities and buildings in OU8 will be conducted in an attempt to locate and determine the extent of the drains and determine optimum sampling locations.

6 4 1.2 Sanitary and Storm Sewer Systems

Another entry point for groundwater contaminants into the sanitary (ASI, 1991c) and storm sewer systems (ASI, 1991a) is via infiltration through joints, cracks, and other types of breaks in the closed conduit. In previous studies, infiltration and exfiltration of the storm and sanitary sewer systems were analyzed using mass-balance techniques (ASI, 1991a and 1991c) This information will be reviewed to determine which segments of pipe for OU8 are likely to have additional water entering from the groundwater table In conjunction with preparation of this Work Plan the currently known information regarding the presence or suspected location of footing drains was summarized by Doty and Associates (Appendix E). This information was taken into consideration in developing the sampling program outlined below

6 4.1.3 Surface-water and Sediment Sampling

Surface-water and sediment sampling may be required within the storm sewer and/or sanitary sewer systems in order to reliably isolate a given IHSS as the source of contaminants This will require knowledge of the existence of perimeter footing underdrains and the location of the connection into sanitary or storm sewer systems or daylight points into drainageways

A copy of the plant utility plans showing the horizonal location of storm/sanitary sewer systems will then be updated to show the locations of each accessible manhole and the location of each known underdrain connection This plan will be used to determine locations for supplemental surface-water and sediment sampling

6 4.1 4 Technical Memorandum 1

TM 1 will be prepared at the completion of Stage 1 activities. This memorandum will present the results of preliminary reviews, site visits, and investigations such as camera inspections of pipes. TM 1 will also discuss any difficulties that the subcontractors may have run into during Stage 1 work, such as coordination with RFP security, etc TM 1 will incorporate the findings and recommendations based on the reviews performed during Stage 1 activities. This information will be processed and analyzed in an effort to identify expected contaminants from known IHSSs located upstream and to determine the source and areal extent of each contaminant. Based on the results of this data interpretation, a decision will be made regarding the need for and recommended locations of additional sampling sites. The TM will include locations, frequency, procedures, and methods and analysis parameters to supplement this FSP and outline efforts for Stage 2 sampling. Further sampling in subsequent stages will be performed to provide a full, complete, and adequate RFI/RI investigation

6.4.2 Stage 2 Investigations

The purpose for Stage 2 surface sampling is to determine the presence of contamination and to support a variability analysis for Stage 3 sampling Currently available historical information and previous sampling data indicate that the possible contaminants at the OU8 IHSSs include all or some combination of radionuclides, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganic contaminants including metals, cations and anions. Radionuclides, VOCs, and metals can be detected and hot spots mapped in the field using real-time screening methods These screening methods can be used to direct subsequent surface and subsurface sampling programs required to characterize the nature and extent of contamination. Because the SVOCs and some of the inorganic compounds are not as easily detected through screening methods, surface and subsurface soil sampling may be the only practical method for determining the nature and extent of contamination In addition, radionuclide and metal screening methods will only detect surface contaminants, therefore, subsequent subsurface sampling may be required to fully determine nature and extent of contamination.

Stage 2 sampling will include conducting a number of screening-level activities to assess the presence of the contaminants of concern at each IHSS Additionally, tank and pipeline inspections will be performed as part of the Stage 2 investigation.

6 4 2.1 Radiation Surveys

The initial task will consist of a surface and shallow subsurface media survey to first determine if significant radiological contamination exists compared to background, and then to provide preliminary definition of the extent of contamination The proposed radiation survey techniques will provide real time results, will identify general areas of primary concern, and will allow subsequent field sampling tasks to be efficiently focused. Radiation survey techniques will include high purity germanium (HPGe) radiation surveys supplemented with gamma activity measurements using a sodium iodide (NaI) scintillation detector. The purpose of the NaI probe is to provide spatial resolution of surficial radioactivity detected with the HPGe. Surface samples of concrete or asphalt, and vertical depth profile soil samples will also be collected to support HPGe surveys as described in this section.

Radiation surveys will be conducted to document the character of surficial radionuclide contamination. HPGe radiation surveys conducted at OU8 IHSSs will be set up on a grid that provides total areal coverage, plus overlap. The HPGe gamma ray detector will be used which is capable of high resolution gamma ray spectroscopy enabling the identification and quantification of gamma-emitting radionuclides. The HPGe results will be supplemented with gamma activity measurements using a NaI probe, one of the best scintillators for detecting gamma photons.

The HPGe detector is mounted either on a tripod or vehicle and placed a set distance above the ground surface to measure gamma rays which originate from surface media. The detector height on the vehicle-mounted system can be varied to accommodate site specific conditions and more narrowly focus the field of view The detector system integrates gamma radionuclide activity over the detector's "field of view", a volume defined by which 90 percent of those gammas originating in the surface media are measured. As with most screening radiation detectors and measuring instruments, it is assumed that radionuclide distribution is relatively homogeneous over the field of view, and that the distribution varies only with depth. It is recognized that the assumption of homogeneity is probably not valid, however, the physics of all probes used to screen a surface for radionuclides requires this assumption Supplemental gamma activity measurements will therefore be taken with the NaI probe to better define anomalous areas within the HPGe field of view. In addition, surficial material samples and depth profile samples will be collected to further define the HPGe results. HPGe results are typically reported as concentration per unit mass, picoCuries per gram (pCi/g).

Gamma rays originating in the soil or surface media (typically asphalt pavement or concrete) are attenuated such that the number reaching the detector decreases exponentially with depth. The attenuation of the gamma rays is a function of the elemental composition of the soil or medium measured The more dense the soils or surface media, the more gamma attenuation that will occur. Where soils are covered by asphalt or concrete, HPGe measurements will reflect the activity of the pavement, rather than the underlying soil. The capabilities of the HPGe detector provide greater areal coverage and higher quality results than G-M shielded and FIDLER instruments and pancake-type detectors outlined in the IAG FIDLER instruments provide relative comparisons of radioactivity at discrete survey points whereas HPGe detectors provide individual radionuclide concentrations over the entire area surveyed.

EG&G currently has in-house capability to conduct HPGe field surveys using a tripod-mounted detector The tripod-mounted detector has an approximate field of view of 14 meters, or approximately 45 feet (ft). The use of the tripod-mounted detector will be in accordance with SOP GT.30 Insitu Characterization for Radionuclides. Vehicle-mounted HPGe instrumentation with a 60 meter, or approximately 195 ft, field of view is anticipated to be available for field use in late fall 1991 The vehicle-mounted HPGe is six to eight times more sensitive than the tripod-mounted unit because it is equipped with more crystals and therefore is the preferred detector for site use provided the IHSS is large enough. Identical results of the same quality but at differing sensitivities are obtained from the tripod-mounted and the vehicle-mounted systems. This allows for direct correlation of the results from the two systems. The large grid spacing proposed for some OU8 IHSSs will be reduced if interferences from buildings require a more focused field of view, or replaced with a tripod-mounted detector, in the event that the vehicle-mounted HPGe either is not available or not effective for the field investigation The SOP for vehicle-mounted HPGe field screening is currently under development. As a contingency, G-M shielded and FIDLER instruments and pancake type alpha detectors will be used at each OU8 IHSS where HPGe is currently proposed if the SOPs are not yet approved prior to OU8 field work, or if site conditions introduce other difficulties.

Vertical depth profile samples will be collected at a subset of the exposed soil HPGe survey locations to determine the vertical extent of radionuclide contamination. Vertical depth profile samples will be collected at 0 to 2, 2 to 4, and 4 to 6-inch vertical depths at locations determined after the survey results are evaluated This information is only required in exposed soil or gravel sites to determine the vertical distribution of gamma-emitting radionuclides contributing to the HPGe survey readings. Vertical depth profile samples are not proposed under concrete or asphalt because these dense surfacing materials attenuate gamma rays and no correlation can be made between surface HPGe measurements and vertical distributions in underlying soils. The vertical depth profile samples will be measured on site for radionuclide concentration using a laboratory HPGe.

Surficial soil and vertical depth profile sampling at the gridded locations using the field HPGe will be supplemented by analysis of additional surficial soil samples, if necessary, and concrete or asphalt samples using a laboratory HPGe. Additional surficial soil samples may be collected at nongrid locations to allow correlation of remote and direct HPGe measurements and to quantify anomalous readings from the NaI probe Surficial soil sampling techniques are described in Section 6 4 2.3 Surficial soil samples and concrete or asphalt samples will be stored in containers for 30 days to allow radon gas to equilibrate with parent radionuclides present in the material matrix After 30 days, an on-site laboratory HPGe will be used to detect concentrations of gamma-emitting radionuclides in the samples. These data will be used to guide further investigation of anomalous radioactive areas. All samples analyzed using the laboratory HPGe will be retained until the results of the analyses have been evaluated Duplicate soil samples will be collected at a subset of sample locations and analyzed in a radiochemistry laboratory to determine the concentration of non-gamma emitting radionuclides and to confirm the HPGe detector measurements

The 30-day lag time for HPGe analysis is not real time, per se, but is more advantageous than the six to nine month turn-around time currently experienced for laboratory radionuclide analysis. The availability of a laboratory HPGe, however, is key to implementation of this plan. An SOP for laboratory HPGe field screening is currently under development, and the laboratory HPGe is scheduled to be available by Spring 1993. In the event a laboratory HPGe is not available by the time OU8 field work commences, samples will be sent to a radiochemistry laboratory for analysis

Radiation Survey Procedure

Radiation surveys will be conducted with a HPGe gamma ray detector developed for high resolution spectroscopy. The HPGe has a broad energy range, exhibits high resolution, excellent gain stability, moderate area averaging, and the ability to identify and quantify all gamma emitting radionuclides. Radiation survey locations are IHSS specific and are discussed in Section 6.5. Vehicle-mounted HPGe detector surveys will be conducted on a 150-ft grid at OU8 IHSSs that are large enough. The HPGe detector provides radionuclide concentrations in soil in picoCuries per gram (pCi/g) of gamma-emitting radionuclides including, but not limited to, potassium-40, radium-226, thorium-232, cesium-137, americium-241, plutonium-239, -240, -241, and uranium-233, -234,-235, and -238 While plutonium is primarily an alpha emitter, gamma and x-rays are also emitted Plutonium emits gamma rays at very low branchings that can be detected with high sensitivity instruments, such as the HPGe detector Tritium and strontium-90 are not detected using this method. The EMD SOP for the HPGe is presently under development and will be available prior to any OU8 field work. Other equipment requirements are listed in Section 5 2 of EMD SOP FO 16

A NaI probe will be used to supplement the HPGe data at IHSSs where buildings or obstructions may limit HPGe effectiveness and to provide spatial resolution of HPGe reading The NaI scintillation detector has advantages over other detectors that include higher probability of interactions per centimeter, a high light yield from deposited energy, and a high atomic number. The EMD SOP for the NaI scintillation detector is currently under development and will be available prior to any OU8 field work.

To supplement the HPGe and NaI probe surveys, vertical depth profile samples, and concrete or asphalt samples collected via procedures in this section, will be surveyed with a laboratory HPGe detector to obtain radionuclide concentrations. A SOP for laboratory HPGe field screening is currently in development and will be submitted prior to any OU8 field work.

Vertical Depth Profile Procedures

Vertical soil depth profile samples will be collected at exposed soil HPGe survey locations to correlate HPGe and NaI probe results with depth distribution and aid in the interpretation of HPGe data. Tentative locations are shown on Figures 6-5 through 6-13 The vertical profile sample locations will be determined after evaluation of the HPGe/NaI probe surveys. However, tentatively it is proposed to take two vertical soil profile samples at small IHSSs and more than two samples at large IHSSs. They will typically be collected with a plug type sampler at 0 to

2, 2 to 4, and 4 to 6 inch depth intervals A SOP for this procedure will be developed and submitted prior to conducting OU8 field work

Concrete or Asphalt Sampling

Concrete or asphalt samples will be collected at areas of anomalous surface activity identified by the HPGe and NaI probe surveys for radionuclide analysis with the laboratory HPGe. The location of concrete or asphalt samples will be determined after evaluation of the HPGe/NaI probe surveys. Samples will be collected with the aid of asphalt or concrete cutters or saws. Procedures for obtaining and analyzing such samples for radionuclides will be submitted in an SOP prior to conducting OU8 field work.

6 4.2.2 Soil-Gas Surveys

VOC screening-level data collection will be done by an active real-time soil-gas survey technique that allows mapping of VOC anomalies as the investigators collect and analyze the vapor samples. Soil-gas samples will be extracted and analyzed in the field at IHSSs with suspected VOC contamination. Initially, soil-gas sampling points will be established on a standard grid at each IHSS with potential volatile organic contamination. Grid size selection is discussed in Section 6.5. The rig will be set up on each point, and will cut through overlying concrete or pavement if present. Soil-gas samples will be collected approximately five feet below ground surface through a 1-inch diameter stainless steel probe rod driven with a hydraulic rig mounted on an all terrain vehicle (ATV) In the event that the sampling probe cannot be driven due to physical barriers in the soil, a boring may be augured to a point just above the desired sampling location. At this point the sampling probe will be inserted into the soil. A vacuum will be applied to the sampling probe to induce air flow (soil gas) from the soil pore spaces into the sampling probe A sufficient volume of soil gas will be purged through the sampling probe to ensure that a representative sample will be obtained A sample of the soil gas will then be collected using a gas-tight syringe inserted through fittings at the top of the sample probe

Once a soil-gas sample has been collected, the sample will be analyzed using a portable field gas chromatograph (GC) The GC will be calibrated for the compounds of interest (Table 6.2), and the results will generally be available the same day the sample is collected. This methodology allows for modifications to the sampling program to be made as the sample results are obtained In addition, once the sample has been run, the results will be analyzed to determine if other peaks occurred during the run. If other peaks do occur, the GC may be recalibrated to those peaks and the split of the original sample run within the allowable holding time to quantify those peaks. All sampling protocol will be in accordance with SOP GT.09, Soil-Gas Sampling and Field Analysis, and SOP GT.19, Field Gas Chromatographies

6.4.2.3 Surficial Soil Sampling

Surficial soil samples will be collected during Stage 2 for analysis of SVOCs, radionuclides, metals and anions, or other compounds of concern based on the released contaminant at each IHSS Surficial soil sampling will be performed in accordance with SOP GT.08, Surface Soil Sampling The purpose of the Stage 2 surficial soil sampling is to collect enough data to determine contaminant variability in order to design a statistically-based sampling program for Stage 3 sampling (as described in Section 5.0) and to determine the presence and nature of contamination. Surficial soil samples will be taken in the following manner:

- In an area where the ground surface is covered with pavement or concrete, soil samples will be taken using the "Grab Sampling" method outlined in SOP GT.8 These samples will be taken from the soil substrate underlying whatever base materials are immediately beneath the pavement and will be located, when possible, in holes cut through the pavement for other screening surveys To be consistent with the following Rocky Flats sampling technique, these samples will be collected 5 cm deep from the top of the collection zone.

- In an area where the ground surface is unpaved (exposed soil surface) composite soil samples will be taken by the "Rocky Flats method" outlined in SOP GT.8 using the 10 cm x 10 cm x 5 cm (deep) sampling jig. Each point on the sampling grid will be overlain with a one square-meter template. In this case, five discrete subsamples will be collected from each grid point and composited into a 2,500 cm3 sample

Surficial soil samples for radionuclide analysis will be analyzed onsite with the laboratory HPGe detector. A subset of surface samples that represent a range of radionuclide concentrations will initially be surveyed with the laboratory HPGe detector, then sent to an offsite laboratory for radionuclide analysis and HPGe verification Nonradiological surficial soil samples will be submitted to an analytical laboratory for analysis. A statistically based method developed by Gilbert (1987) (described in Section 5 0) has been used to develop sampling grids across the IHSSs targeted for surface sampling. Section 6.5 describes the sampling grids determined for each IHSS Prospective sampling locations are shown on the individual maps provided for those IHSSs from which surface soil samples will be collected.

Typical RFI/RI surface soil sampling SOPs call for samples to be collected by trained personnel with a suitable instrument (e.g., a precleaned stainless steel trowel) and placed in an appropriately-labeled sample container. The sample will be described according to SOP GT.1 Logging Alluvial and Bedrock Material by field personnel. Sampling instruments will be completely cleaned and decontaminated between samples. Sample preservation will be achieved by cooling with ice. Transfer of the samples to a certified laboratory will be accomplished within a time frame such that the laboratory receives the samples with enough remaining time to allow them to perform their standard operating procedures for receiving samples and performing the applicable analyses without exceeding holding times. Detailed documentation of sample collection and chain-of-custody will be completed for each sample All samples will be screened for gross radioactive contamination prior to shipment to the analytical laboratory.

6 4 2 4 Tank and Pipeline Inspections

Tanks, valve vaults, and underground pipes constitute the primary contamination source in some of the OU8 IHSSs. The physical condition of these structures, as well as the presence of residual product or waste materials, will bear upon site characterization and selection of remedial alternatives. Stage 2 activities will include inspection of above ground piping or other ancillary structures, pressure testing and residue sampling (where appropriate) of tanks, drain systems, and pipelines associated with OU8 IHSSs.

6 4.2.5 Surface-water and Sediment Sampling

Surface-water and sediments will be sampled based on the FSP presented in TM 1. Surface-water sampling points should be located at outfalls of storm sewer systems and underdrain trunk lines, upstream of confluence points between two open drainageways, and within open drainageways, where applicable The sediment samples will be collected in areas of the drainageways that are exhibiting signs of channel-bottom aggradation, such as wide, flat areas, or immediately upstream of control structures. If sediments are saturated, a core sampler with a core liner will be used to collect the top two inches of bed materials for analysis of volatile organics. Samples for nonvolatile analysis will be collected with a stainless scoop. The surface-water and sediment sampling efforts will proceed in accordance with SOPs SW.03, Surface Water Sampling, SW.04, Sediment Sampling, and FO 13, Containerization, Preserving, Handling and Shipping of Soil and Water Samples.

6 4.2.6 Technical Memorandum 2

TM 2 will be prepared at the completion of Stage 2 sampling. This memorandum will present the results of the HPGe, NaI probe, alpha scan, soil-gas surveys, vertical profile soil sampling results, surface soil sampling results, surface-water and sediment sampling, and the tank, valve vault and pipeline inspection/sampling program results TM 2 will also include proposed sampling locations to confirm both positive and negative results from the Stage 2 screening investigations, determine extent of contamination, and present a statistical sampling program.

6 4 3 Stage 3 Investigations

Stage 3 investigation will include collection of additional surficial materials samples (i.e. soil, asphalt, concrete) to determine the extent of contamination that was detected during the Stage 2 field efforts. This stage will also include drilling soil borings to collect soil samples for chemical analyses and analyses of geotechnical and geochemical properties. In the event that these borings reach groundwater, a BAT® sampler or equivalent may be used to collect groundwater samples Stage 3 activities may also include surface-water and sediment sampling.

6 4.3.1 Surficial Soil Sampling

Additional surface soil sampling may be performed as part of the Stage 3 investigation. If Stage 2 sampling indicated the presence of surface contamination, surface soils may be collected according to the procedures described earlier, to better define the nature of contamination and to determine the extent of contamination. Additional surface soil sample locations and frequency will be presented in TM 2 TM 2 will also provide analysis to be performed on the additional samples.

6.4.3.2 Soil Borings and BAT® or Equivalent Sampling

Using results of the screening and sampling activities described above, a soil boring and groundwater sampling program will be conducted to investigate and quantify the extent of contamination at potentially anomalous areas. The primary objective of soil borings is to collect soil samples for laboratory analysis to determine the nature and extent of subsurface contamination and to confirm the Stage 2 results Also, soil samples will be collected for analyses to determine the total organic carbon (TOC), grain size distribution, Ph, bulk density, and porosity At each location geologic and hydrologic data, such as depth and nature of subcropping bedrock and depth to water table, will also be obtained. The borings will be drilled down to the water table or 6 feet into the bedrock, whichever is more shallow Soil samples will be collected from the surface to the total depth of the boring or to the top of the water table, whichever is more shallow. Figures 6-1 and 6-2 show the proposed sampling schemes In the event that samples are collected for VOC analyses, discrete samples will be collected at 4-foot intervals Soil samples that are collected for analyses other than VOCs will be composited to represent the first 2 feet and then 6-foot intervals to follow.

Boring locations will be marked and surveyed prior to drilling Soil borings will be completed in accordance with the following SOPs:

- SOP GT.17 Land Surveying
- SOP GT.10 Borehole Clearing
- SOP FO.03 General Equipment Decontamination
- SOP FO.04 Heavy Equipment Decontamination
- SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques
- SOP GT.01 Logging Alluvial and Bedrock Material
- SOP FO.08 Handling Drilling Fluids and Cuttings
- SOP GT.05 Plugging and Abandonment of Boreholes
- SOP FO.09 Handling of Residual Soil Samples
- SOP FO.18 Environmental Sample Radioactive Content Screening

Field personnel are also required to fully document the drilling operation and to record detailed geologic and hydrologic information as the hole progresses.

Hollow stem auger drilling is the typical method used for soil borings at RFP. The SOPs specify continuously-sampled borings, in which a thin-walled sampler attached in advance of the auger cutting head allows undisturbed samples to be taken continuously as drilling progresses Continuously-sampled borings require detailed physical descriptions of the materials sampled. Also, results from field screening instruments will be recorded (e.g., HNu/OVA headspace readings). Samples for analysis will be taken from the continuously-sampled material. The intervals from which these are removed will be carefully marked and documented Remaining samples will be placed into appropriately-labeled containers (typically core boxes) and logged into a designated storage facility.

Once total depth has been reached at specified borings, a BAT® sampler, HydroPunch® or other temporary groundwater sampling techniques, as required to adequately screen the selected site, will be used to collect groundwater samples for presence/absence of contamination. The boring will then be advanced to just below the sampling depth following sample collection in order to characterize the geology of the sampled zone.

The BAT® System contains three basic components a permanently installed, sealed filter tip attached to an extension pipe; an evacuated and sterilized glass sample container, and; a disposable, double-ended hypodermic needle. All elements of the BAT® System are hermetically sealed. A temporary, leak-proof hydraulic connection between the filter tip and the sample container is achieved by penetration of the hypodermic needle through two flexible discs. Due to the under pressure in the evacuated container, water is drawn into the sample container via the filter tip Depending on the amount of water that is present in the formation, several samples may be collected consecutively using this method (it may be desirable to collected multiple samples since the sample vial will only hold 500 ml of water) The time required to fill the sample container will depend on the permeability of the soil.

Because the collected sample volume obtained by the BAT® sampler (500 ml) and HydroPunch® is small, and it could become very time consuming to obtain large quantities of water, sample analysis will be limited to target compound list (TCL) volatiles, nitrates and chromium by calorimetric methods, and target analyte list (TAL) metals The FSP within TM 2 will specify the number and location of groundwater samples to be collected by the BAT® or equivalent sampler in the event that the BAT® sampler is used, sampling will be performed in accordance with SOP GT.22, <u>In-Situ Sampling with BAT Sampling</u> Following the collection of the groundwater sample and subsequent drilling, the boring will be plugged and abandoned according to SOP GT.05.

Groundwater samples will be collected by trained personnel with suitable instrumentation and placed in an appropriately labeled sample container. The sample collection technique and surrounding circumstances will be described as completely as possible by field personnel Sampling instruments will be completely cleaned and decontaminated between samples. Sample preservation will be achieved by cooling with ice Transfer of the samples to a certified laboratory will be accomplished within the maximum time allowable for the applicable analyses. Detailed documentation of sample collection and chain-of-custody will be completed for each sample. The samples will be screened for gross radioactive contamination by the contractor prior to shipment to the analytical laboratory.

6 4 3 3 Geotechnical and Geochemical Data

A minimum of two soil samples will be collected for the analysis of physical parameters from each sedimentologic unit encountered while drilling soil borings at each IHSS. Continuous coring methods will allow collection of relatively undisturbed samples for testing of physical parameters. These samples will be tested to determine moisture content and grain size distribution using both sieve analysis and hydrometers, bulk density, and porosity A minimum of two saturated and unsaturated samples will also be collected from each IHSS for the determination of total organic carbon (TOC) content, cation exchange capacity, and soil Ph This physical information is necessary for conducting the baseline risk assessment and evaluating the feasibility of future remedial actions.

Soil samples for geotechnical analysis require a minimum amount of disturbance and will be collected in thin-walled metal tubes The thin-walled metal tube will be driven into the undisturbed soils in advance of the hollow-stem auger, removed, and the tube sealed for transport to the laboratory Any changes to these geotechnical sampling procedures will be the subject of a DCN.

6.4.3.4 Technical Memorandum 3

The results of Stage 3 will be presented in TM3. TM3 will also outline the FSP for Stage 4 activities

6 4 4 Stage 4 Investigations

Following evaluation of the work performed for Stages 2 and 3, as presented in Technical Memorandum 3, it may be evident that further investigations are warranted at certain IHSSs. Figure 6-3 shows a logical sequence of events that could lead to additional investigation. Stage 4 sampling may include additional soil borings and BAT® or equivalent sampling to fully assess the extent of contamination at some of the OU8 IHSSs. In the event that additional soil borings and/or BAT® or equivalent sampling are justified, the drilling and sample collection methods and techniques will be the same as outlined in the above section Soil samples may be collected for both geochemical analyses and geotechnical analyses.

Stage 4 sampling will also include leachability tests on soil samples collected from the soil borings and installation of soil tensiometer and piezometers

6 4.4 1 Soil Borings and BAT® or Equivalent Sampling

If Stage 3 subsurface sampling indicates the presents of contamination but has not fully assessed the extent of contamination, additional soil borings and/or groundwater sampling will be necessary If additional subsurface investigation is warranted, soil borings and groundwater sampling will be performed as described in Stage 3.

6 4 4 2 Leachability Testing

Predicting the mobility of suspected constituents through leachability testing will aid in developing a monitoring plan and remedial actions for subsequent Phases for OU8. These predictions may also be used to estimate the probable vertical or lateral extent of contamination. There are several means of investigating mobility; however, leaching tests have the advantage of being the only approach that integrates soil and constituent properties in a single evaluation Also, leaching tests may provide a conservative estimate of the concentration within leachate of waste constituents that may eventually impact groundwater. Therefore, soil samples will be collected within the vadose zone during the soil boring program for leach test analysis. These samples will be collected at intervals specified by, and handled according to, the FSP within TM 3 A soils/waste mixture leaching procedure, known as the Synthetic Precipitation Leach Test (Method 1312) has been developed by the EPA. This method is outlined in Appendix F, Volume II of the "Interim Final RCRA Facility Investigation (RFI) Guidance", (EPA, 1989a). It is suggested that this method be used for leaching tests.

6 4 4 3 Soil Tensiometers

Tensiometer will be installed to determine presence and depth of wetting fronts in the vadose zone Tensiometer provide information on soil matric potential and commonly have an operating range or 0.0 to 0.6 bars Standard nested tensiometer equipped with pressure transducers, or equivalent moisture monitoring equipment, may be installed to measure matric potential of water in the unsaturated zone The tensiometer will likely consist of a porous ceramic cup attached to a rigid plastic tube. The internal volume of the system will be completely filled with water. The pores in the cup form a continuum with the pores in the soil. Water will move either into or out of the tensiometer system until equilibrium is attained across the ceramic cup Multiple tensiometers allow for the determination of the direction, and in some cases the quantity, of water flux from the ground surface to the water table Nested tensiometer arrays will be installed at select OU8 IHSSs Each array will consist of multiple tensiometers buried at 2-ft intervals from 1 ft above the water table to within 2 ft of the ground surface. The tensiometer will be installed using the hydraulic probe to minimize the soil disturbance. The probe holes will be backfilled with uncontaminated naturally occurring soils to a compaction slightly greater than the bulk density of the undisturbed soils to reduce surface water infiltration, which results in abnormally low tensions in the backfill and the undisturbed soil.

Water used in the tensiometer must be de-aerated and onsite purging may be necessary to prevent the formation of bubbles which can prevent accurate data collection. Purging time will be kept short to minimize wetting of soil adjacent to the porous tensiometer cup. When purging is complete, the system is closed and the soil draws water through the porous cup until equilibrium is established and the pressure is recorded by the pressure transducer and data logger.

The tensiometer will be monitored for as long as the project schedule allows Tensiometer will be installed and utilized according to SOP GT.31 Field Use of Tensiometer. Tensiometer can be inserted by drilling small diameter boreholes either with hand augers or with a ATV-mounted hydraulic probe. Subsurface geologic conditions may limit the success of these installation methods, although other methods exist. Transducers connected to the tensiometer produce *in-situ* readings of soil-water pressure which are recorded electronically in digital form. Soil-water pressure measurements are then used to determine response of vadose zone moisture to precipitation events, and to evaluate whether soil wetting fronts reach the water table. In areas where infiltration is found to reach the water table, a potential method to be used in evaluating the mobility of contaminants present in the vadose zone is leachability tests

6 4 4 4 Piezometers

Piezometers will be installed in order to collect local groundwater elevations and assess the subsurface flow regime. This information will assist in the interpretation of the hydrology of OU8, assist in developing remedial alternatives, and help guide the location for installation of groundwater monitoring wells which may be installed during Stage 5 activities. Peizometers will be installed according to SOP.GT6 Monitoring Wells and Piezometer Installation, and SOP.GT2 Drilling and Sampling Using Hollow-Stem Auger Techniques.

6 4 4.5 Technical Memorandum 4

The results of Stage 4 activities will be presented in TM 4, which will also outline the FSP for Stage 5 if Stage 5 sampling is required.

6 4.5 Stage 5 Investigation

6 4 5 1 Groundwater Monitoring Wells

Stage 5 sampling may include installation of groundwater monitoring wells. Alluvial ground water monitoring wells will be completed based on results of field screening and soil boring programs. Alluvial monitoring wells will be installed at IHSSs where history, screening data, and soil boring data indicate ground water may have been contaminated. All monitoring wells installed during the RI/RFI process will be sampled quarterly for one year. Validated data will be presented in the RFI/RI report. Subsequent sampling rounds will be discussed in a TM. Alluvial monitoring wells will be installed according to SOP GT.01 Logging Alluvial and

Bedrock Material, SOP GT 02 Drilling and Sampling Using Hollow-Stem Auger Techniques, SOP GT.06 Monitoring Wells and Piezometer Installation and SOP GT.02 Well Development. These wells may be installed upgradient and downgradient of certain IHSSs The location of these wells will be based on the results from the field efforts performed in Stages 2 through 4 The purpose of these wells would be to define the nature and extent of groundwater contamination related to OU8 IHSSs

All monitoring wells will be constructed with materials specified in EMD SOP GW 6. A hollow-stem auger with an inner diameter a minimum of 4 inches larger than the well casing outer diameter will be used to drill the monitoring wells to produce a minimum annular space of 2 inches. Well construction techniques will follow procedures outlined in EMD SOP GT.6 Investigation-derived wastes such as cuttings and residual samples will be handled in accordance with guidelines outlines in EMD SOP FO.8.

Well construction techniques for all monitoring will follow procedures contained in EMD SOP GT.6. Monitoring wells in high-traffic paved areas will be completed flush with the pavement. Wells in areas not exposed to vehicular traffic will be protected by the placement of steel posts around the monitoring wells, as described in EMD SOP GT.3. Additional equipment and materials that may be needed for monitoring well installation are listed in EMD SOP GT.6, Section 5.1; other related EMD SOP are cross-referenced in Section 4.2 of EMD SOP GT.6.

The wells will be developed no sooner than 48 hours and no longer than two week after completion and will not be sampled until at least two weeks after development. Water levels will be measured in all wells and recorded as outlined in EMD SOP GW.1 and the appropriately cross-referenced EMD SOP listed in Section 4 2 of the EMD SOP GW.1. After the water levels reach static conditions, the wells will be developed utilizing low-energy methods, such as an inertial pump or bottom discharging bailer. Well development will follow procedures outlined in EMD SOP GW.2.

Purging procedures will follow those contained in EMD SOP GW 6 and include purging of three to five casing volumes of water or other appropriate criteria. Field parameters (Ph, specific conductance, temperature) will be measured after every half casing volume is removed as described in EMD SOP GW 6

Ground water samples will be collected in a manner that will minimize the amount of agitation or limit the exposure of the sample to the atmosphere. Ground water sampling will be by bailing or the use of a bladder or peristaltic pump. Samples will be collected, handled, and screened in accordance with EMD SOP GW 6 and all related EMD SOP All development and purge water will be handled in accordance with guidelines outlines in EMD SOP FO.8. Equipment needed for ground water sampling is listed in EMD SOP GW.6

Field parameters will be measured when each ground water sample is collected. Specific conductance, Ph, temperature, dissolved oxygen, redox potential, total alkalinity, and turbidity will be measured when ground water samples are collected in accordance with EMD SOP GW.6 Water level measurements will be conducted in accordance with EMD SOP GW 1 and the appropriately cross-referenced EMD SOP listed in Section 4 2 of this EMD SOP GW.1

6 4.6 Surveying of Sample Locations

The locations of all radiation survey points, soil-gas survey points, borings, piezometers, tensiometers, monitoring wells and surface sampling points will be measured with a steel tape prior to sampling or drilling. After sampling, drilling, or well installation, locations will be surveyed using standard land surveying techniques described in the EMD SOP GT.17. Horizontal accuracy will by ±0.5 ft for surficial soil samples, soil gas survey points, and borings and ±0.1 ft for piezometers, tensiometers and wells Vertical accuracy will be ±0 1 ft for borings and ±0.01 ft for wells, piezometers and tensiometers. Three elevations will be determined for each well and piezometer: ground surface, top of well casing, and top of surface casing.

6.5 SAMPLING LOCATION AND FREQUENCY

This section describes the specific field investigations proposed for each IHSS including sample locations and frequencies Table 6.3 presents a summary of the proposed field investigations program for OU8. Table 6 4 shows the number of sample or survey locations for each IHSS. Sampling activities and analytical parameters for this OU8 FSP are based on IHSS-specific conditions and historical use, and are designed to define the nature and extent of contamination at OU8 IHSSs and investigate potential migration pathways Table 6.5 shows a summary of the analytical program to be followed during the implementation of the FSP

There are no previous data available at any of the OU8 IHSSs to bias the location of proposed sample points. The only available information on the IHSSs are descriptions of the historical use, and documentation of historical spills and releases which are included in HRR. In most instances, the exact location of reported releases was not given, and many of the releases were not verified Clean up activities, if any, were not documented Therefore, in designing the field sampling program, consideration was given to defining the location and extent of possible historical releases with an acceptable level of confidence in the data. Because that level of confidence is a direct reflection of data quantity and quality, the objectives of the program were to provide adequate data for statistical evaluation. The quality and quantity of the program will be evaluated using methods described in Section 5.0, Data Quality Objectives and Data Needs.

The field sampling program described in Section 6 5 and applied to each IHSS in the following sections provides for screening and surficial soil sampling to be initially completed on a standard grid, with additional sample points added to further define anomalous readings. The use of quick and relatively inexpensive screening methods allows for the determination of general site conditions, as well as to qualitatively identify contaminated areas at each IHSS. It is realized the success of such methods is somewhat dependent on subsurface geology in the OU8 area.

The approach used to determine grid spacing and sample locations for the different screening and sampling activities within this work plan considered not only statistics as described below and site history, but the capabilities of the technologies used. For example, the vehicle-mounted HPGe radiation surveys proposed in this plan provide soil concentration results representing an approximate 195-foot (ft) diameter circular area, not just a single point. Therefore, grid spacing for HPGe radiation surveys may be set at 150 ft for large areas, which provides for total coverage of a site Tripod-mounted HPGe surveys are established on a 30-ft grid to supplement vehicle-mounted surveys and the NaI probe is conducted on even a finer grid, 15 ft or less. The vehicle-mounted HPGe is unable to remotely detect radionuclides present in soils beneath concrete or pavement. Surficial soil samples will therefore be collected in concrete or paved areas on uniform grids for direct radionuclide measurement. In exposed soil areas, where the vehicle-mounted HPGe measurements are representative of radionuclide activities in soil, minimal numbers of confirmatory surficial soil and vertical depth profile samples will be collected.

The statistical approach used to determine the sample location is taken from a method developed by Gilbert (1987) and is also presented in EPA documentation (EPA, 1989e). This method allows for the determination of a sampling grid spacing dependent on a target contaminated area size and specified confidence. This method assumes the following. the target is circular or elliptical; samples are collected on a square, rectangular, or triangular grid; the area between the grid points is much larger than the actual area defined sample collection and analysis sampled; and the definition of the contaminated area is clear and unambiguous The last assumption is difficult to meet at OU8 IHSSs because the size of the reported spills or releases is not known.

The acceptable probability (β) of not finding the target contaminated area is specified as 0.1 or 10 percent, in accordance with EPA guidance (EPA, 1990). A triangular grid was chosen because studies have shown that triangular grids are less likely to fail to identify a given target than square grids (Gilbert, 1987). Based on the Gilbert methodology, triangular grids spaced at approximately 24 ft are within acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 25 ft in size The sizes of the smaller OU8 IHSSs are less than 100 ft by 50-ft, although spill areas within the IHSSs may be smaller. Likewise, a triangular grid with samples spaced a maximum of 50 ft apart proved an acceptable probability of not finding an elliptical contaminated area approximately 50 ft by 100 ft in size The larger IHSSs are all greater than 50 ft by 100 ft in size, but potential anomalous areas within them may be smaller.

The soil-gas and surficial soil sampling programs will be established on 25-ft triangular grids at most OU8 IHSSs that are less than 5,000 ft^2 in area, with provisions for additional points to be added in suspect locations (i e soil staining near doors of loading docks or where drum handling activities are associated with likely spills). For IHSSs larger than 5,000 ft^2 in area, soil-gas and surficial soil sampling will be done on 50-ft triangular grids. The starting grid point at each site is chosen using random methods described in EPA guidance (EPA, 1989e). Additional samples will be collected midway between grid nodes if anomalous screening results are obtained.

HPGe radiation surveys will be conducted on a triangular grid centered on a 30 to 50-ft grids. NaI probe locations are set at 15-ft grid spacings or less. Additional surficial samples may be collected midway between survey points with radioactivity in excess of preliminary remedial action criteria. Such additional points would be determined in the field.

The screening data will be assembled and summary statistics (including coefficient of variation and power) will be calculated for each IHSS and each parameter Should the computed power fail to meet the requirements for the risk assessment, additional samples will be collected and analyzed The number of additional samples that will be collected are to be determined using calculations provided in EPA guidance (EPA, 1990).

The additional samples will be located using geostatistical techniques. Unlike classical statistics which assume independence of samples, geostatistics assumes that the data are spatially correlated. Using this analytic approach, the mean concentration and variance of the mean can be estimated at any given location in the contaminated area, and decisions about where additional samples should be collected can be objectively made

As a first step in this process, the spatial interdependence of samples in two dimensions will be expressed through the development of calculated, and then modeled, semivariograms The semivariograms will provide a measurement of the uncertainty that exists when a sample concentration is used to estimate the concentration of a contaminant in soil in the surrounding area.

Second, mean concentrations will be estimated across the contaminated area with the geostatistical method referred to as kriging Kriging uses the information from the semivariogram to find an optimal set of weights that allow estimation of concentrations at unsampled locations The kriged estimates will be displayed in the form of a contour map showing sampled and estimated concentrations throughout the IHSSs

Unlike contour maps prepared with conventional contouring algorithms, a kriged contour map has certain optimal statistical properties Most important, the method provides measures of the error or uncertainty of the contoured surface (Davis, 1986) Therefore, a separate contour map of the standard error of the estimate (error map) will be prepared in addition to the map of contaminant concentrations referred to above. The standard error is a confidence band about the estimate Additional samples will be located in areas with the highest standard error.

6 5 1 Solvent Spills (IHSS 118.1)

Carbon tetrachloride (CTET) was released into a concrete sump constructed next to a CTET underground storage tank (UST) and onto the ground surface at this site. The CTET surface spills were washed down with large quantities of water, therefore, the area of investigation will extend beyond the current IHSS boundaries (Figure 6-5) Following the release, the UST was removed. Stage 1 activities for this site should include determining if the concrete containment was removed when the tank was removed

Stage 2 investigations will be conducted within the IHSS boundary and in the area east and south of the IHSS boundary as shown on Figure 6-5 These will include conducting a soil-gas survey at this site. Soil-gas samples will be collected on a 25-foot grid resulting in 7 sample locations (Figure 6-5) and will be analyzed for the compounds of interest listed in Table 6.2.

Stage 3 investigations to be performed at this site will include the installation soil boring(s). TM 2 will recommend the location and frequency of soil borings. It is recommended that a total of 4 boreholes be drilled, one borehole where the tank was located, one borehole where the sump was located (provided the concrete sump has been removed), one borehole upgradient of the IHSS, and one downgradient of the IHSS Soil samples collected from these borings will be analyzed for TCL volatiles Also, geophysical and geochemical samples will be collected as described in Section 6 4 4.2. If groundwater is encountered during borehole installation, a BAT® sampler will be lowered into the borehole and a groundwater sample collected and analyzed for TCL volatiles.

The results of the Stage 3 investigations will be summarized in TM 3 and further sampling may be recommended

6.5.2 Solvent Spills (IHSS 118.2)

Carbon tetrachloride was released onto the ground surface from an aboveground storage tank. Degreasing solvents such as CTET, petroleum distillates, benzene and dichloromethane paint thinner, 1,1,1-trichloroethane (TCA) and methylethylketone (MEK) may have been stored at or adjacent to this site. Stage 1 activities for this site should include determining if the tank was removed from the site and if there are any access problems unknown at this time.

Stage 2 investigations will include conducting a soil-gas survey to locate areas of contamination. The soil-gas survey will be conducted on a 10-foot grid due to the size of the IHSS, resulting in 7 sample locations (Figure 6-6) and will be analyzed for the compounds of interest listed in Table 6 2 The sampling locations may be adjusted to define anomalous hot spots if necessary

Stage 3 investigations to be performed at this site will include the installation soil boring(s) for assessment of nature and extent of contamination and confirmation of Stage 2 investigation of soil borings TM 2 will recommend location and frequency based on the soil-gas survey results. Soil samples collected from these borings will be analyzed for target compound list (TCL) volatiles Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4.2. If groundwater is encountered during borehole installation, a BAT® sampler will be lowered into the borehole and a groundwater sample will be collected and analyzed for TCL volatiles.

The results from the Stage 3 investigations will be summarized in TM 3 and further sampling may be recommended.

6 5.3 Valve Vault 7 (IHSS 123.1)

Valve vault 7 is a valve vault located on the process waste lines. This valve vault malfunctioned allowing process waste water to spill out onto the ground surface. The release consisted of uranium, solvents, oils, beryllium, nitric and hydrochloric acids, and fluorides

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations

Since the release included a myriad of contaminants, Stage 2 investigations are fairly extensive. Stage 2 investigations will include conducting a radiological survey on a 30-ft grid resulting in

14 sample locations, collection of 4 vertical soil profile (VSP) samples, collection of surface soil samples, and implementation of a soil-gas survey The surface soil sample collection and soil-gas survey will be conducted on a 50-foot grid, resulting in 9 sample locations (Figure 6-7) The surface soil samples will be analyzed for nitrate, Ph, fluoride, and TAL metals, the soil-gas survey will analyze for the compounds of interest listed on Table 6.2.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) and collection of groundwater samples via the BAT® if groundwater is encountered TM 2 will specify the number and location of soil borings to be drilled. Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4.4.2 TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5.4 Cooling Tower Blowdown (IHSS 135)

IHSS 135 consists of a containment pond and connecting drainage that was affected by cooling tower blowdown water. This water may have contained phosphates, chromate, and tritium.

Stage 1 activities as described in Section 6 4 1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations will include collecting surficial soil samples on a 50-foot grid, resulting in 5 sample locations (Figure 6-8). These samples will be analyzed for total chrome and tritium.

Stage 3 may include additional soil sampling and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination and collection of groundwater samples via the BAT® if groundwater is encountered. If soil borings are required, TM 2 will specify the number and location of soil borings to be drilled. Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings If soil borings are installed, it is currently proposed that the soil and groundwater samples be analyzed for chrome and possibly tritium Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling

6.5.5 Cooling Tower Blowdown (IHSS 137)

The ground surface between and surrounding Buildings 712 and 713 has been impacted by cooling tower water from drift, blowdown, and leaks. Chromates and phosphates have been added to this water as algicides and rust and corrosion inhibitors.

Stage 1 activities such as document review and site visits will be performed as required to enhance subsequent stage investigations

Stage 2 investigations will include collection of surface soil samples on a 50-foot grid, resulting in 7 sampling locations (Figure 6-5) Surface soil samples will be analyzed for total chromium.

Stage 3 investigations may include additional surficial soil sampling and will include the installation of soil borings for confirmation and/or assessment of nature and extent of contamination and collection of groundwater samples via the BAT® if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled. Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. It is currently proposed that soil and groundwater samples be analyzed for total chromium. Also, soil samples will be collected from the soil borings for analysis of geophysical of geochemical properties as described in Section 6 4 4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6 5 6 Cooling Tower Blowdown (IHSS 138)

Both the subsurface and the ground surface were impacted by cooling tower water The subsurface was impacted by an underground pipe failure and the surface was impacted by a release from a backed up sump Based on sampling conducted following the release and on process knowledge, the cooling tower water may have contained chromium, Nalco 2826 (an inorganic phosphate), and alpha activity.

Stage 1 activities as described in Section 6 4 1 will be performed as required to enhance subsequent stage investigations

Stage 2 investigations will include conducting a radiological survey on a 30-ft grid resulting in 4 HPGe and 2 VSP locations. Also surface soil samples will be collected on a 25-foot grid, resulting in 9 sample locations (Figure 6-9) These samples will be analyzed for total chromium.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination and collection of groundwater samples via the BAT® if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled. Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. It is currently proposed that the soil and groundwater samples be analyzed for chromium. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling

6.5.7 Hydroxide Tank Area (IHSS 139 1(N) & 139.1(S))

The ground surface has been affected by NaOH due to a number of spills from an aboveground storage tank and seepage from deteriorating tanks at the two separate IHSS 139 1 sites. At IHSS 139 1(S), the ground surface has been affected by KOH spills at an aboveground storage tank location

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations at IHSS 139.1(N) will include collecting surface soil samples on a 25-foot grid, resulting in 8 sample locations (Figure 6-10) These samples will be analyzed for Ph. Stage 2 investigations at IHSS 139.1(S) will include collecting 3 soil samples on a 25-foot grid (Figure 6-5) from the soil beneath the gravel backfill. These samples will be analyzed for Ph.

Stage 3 investigations at IHSS 139.1(N) may include additional surficial soil sampling and may include the installation of one confirmation soil boring at the pipe leak next to Building 774 and one confirmation boring at a location determined by surface soil sampling near the two condensate tanks. Also groundwater samples will be collected via the BAT® if groundwater is encountered in these borings, and a groundwater sample will be collected from Well P219089. The soil and groundwater samples will be analyzed for Ph Also, soil samples will be collected, from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4 4.2.

Stage 3 investigations at IHSS 139.1(S) may include additional surficial soil sampling and may include the installation of one soil boring within the berm at the KOH tank site. Also groundwater samples will be collected via the BAT® if groundwater is encountered in this boring. The soil and groundwater samples will be analyzed for Ph Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5.8 Hydrofluoric Acid Tank (IHSS 139.2)

The hydrofluoric acid release at this IHSS consisted of a vapor release It is improbable that there is a residual impact on the air. Also it is not likely that soil, surface water, or groundwater has been impacted by this release Therefore, no further investigation is required at this site. There is, however, a refillable nitric acid dumpster located approximately 25 feet northwest of this site. Leaks and spills from this dumpster have likely impacted the surrounding ground surface

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations will include collecting surface soil samples from beneath the asphalt and subgrade materials at the nitric acid dumpster location on a 25-foot grid, resulting in 3 sample locations (Figure 6-5). These samples will be analyzed for nitrate and pH.

Stage 3 may include additional surficial soil sampling and may include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination and collection of groundwater samples via the BAT® if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Currently it is proposed that the soil and groundwater samples be analyzed for Ph and nitrate. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4 2 TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling

6.5.9 Sewer Line Breaks (IHSS 144)

IHSS 144 is divided into two separate areas, IHSSs 144(N) and 144(S). The subsurface has been affected at both of these sites due to underground tank releases and a ruptured pipeline, respectively Additionally, the ground surface west of IHSS 144(N), east of Building 701, was also affected by the ruptured pipeline incident. The releases consisted of process waste and laundry waste. It is assumed that radionuclides, metals, and organic chemicals were included in this release.

Following the 1972 pressurization incident, the Building 995 outfall and other downstream points were sampled daily. There was increased radioactivity in the Building 995 outfall. The highest sample concentration of total alpha-emitting radionuclides in the outfall was 417 Pci/l on June 11, 1972 (Appendix B).

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations.

Stage 2 activities consist of collecting sediment samples downstream of Building 995 outfall and analyzing the samples for target analyte list (TAL) metals, radionuclides (i.e., total plutonium, total americium, tritium, uranium-233/234, 235, and 238, gross alpha, and gross beta), and SVOCs. Additionally, a soil-gas survey and surficial soil sample collection will be conducted on a 25-foot grid at IHSSs 144(N) and 144(S), resulting in 5 and 7 sample locations, respectively (Figure 6-5 and 6-9) Samples collected for soil-gas will be analyzed for the compounds of interest listed on Table 6.2. Surface soil samples will be analyzed for SVOCs and TAL metals. A 15 x 15 foot area next to the doorway on the east of building 701 will be also be investigated to determine the presence/absence of contamination on the ground surface. In this area one radiological measurement and one VSP will be taken Also at this location, surface soil samples will be collected on a 25-foot grid resulting in 3 sample locations and analyzed for TAL metals.

Stage 3 may include additional surficial soil samplings and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination and collection of groundwater samples via the BAT® if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Currently it is proposed that the soil samples be analyzed for TAL metals, radionuclides, VOCs and SVOCs and groundwater samples be analyzed for TAL metals, VOCs and SVOCs. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5.10 Radioactive Site (IHSS 150 1)

The ground surface has been affected in this area due to a variety of surface releases (see Section 2.4.1.10) These releases are suspected to have consisted of plutonium, nitric acid, and process waste that consisted of radionuclides, metals, and organic chemicals

Stage 1 activities as described in Section 6 4 1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations will include conducting a radiological survey on a 40-ft grid resulting in 12 HPGe and 4 VSP locations. A soil-gas survey and surficial soil sample collection will be conducted on a 50-foot grid, resulting in 10 sample locations (Figure 6-11). Samples collected during the soil-gas survey will be analyzed for the compounds of interest listed on Table 6.2. Surficial soil samples will be analyzed for SVOCs and TAL metals.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination and collection of groundwater samples via the BAT® if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Currently it is proposed that the soil samples be analyzed for radionuclides, TAL metals, VOCs, and SVOCs Also, soil samples will be collected from of the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5 11 Radioactive Site (IHSS 150.2)

The ground surface was contaminated with radionuclides, most likely plutonium, from fires and fire-fighting activities.

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations will include conducting a radiological survey on a 65-ft grid, resulting in 10 HPGe and 4 VSP locations (Figure 6-12).

Stage 3 will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination TM 2 will specify the number and location of soil borings to be drilled Additionally, TM 2 will specify the analyses required for the soil samples collected in the soil borings Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4.2 TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling

6.5 12 Radioactive Site (IHSS 150.3)

Surface and subsurface materials were likely affected by a deteriorated subsurface concrete tunnel containing process waste lines and soil excavation activities surrounding the tunnel The release is assumed to have consisted of plutonium and other unspecified radionuclides, metals and organic chemicals

Stage 1 activities as described in Section 6.4.1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations will include conducting a radiological survey on a 30-ft grid, resulting in 7 HPGe and 3 VSP locations. Also a soil-gas survey and surficial soil sampling will be conducted on a 25-foot grid resulting in 7 sample locations (Figure 6-11). Samples collected during the soil-gas survey will be analyzed for the compounds of interest listed on Table 6.2. Surficial soil samples will be analyzed for SVOCs and TAL metals.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination. Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled. Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4 4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6 5 13 Radioactive Site (IHSS 150 4)

Surface materials were affected at this IHSS due to a leaking overhead process waste line, and possibly airborne contamination from the 1969 fire. It is assumed that this release consisted of radionuclides, metals, and organic solvents

Stage 1 activities as described in Section 6 4.1, will be performed as required to enhance subsequent stage investigations

Stage 2 investigations will include conducting a radiological survey on a 30-ft grid with 1 HPGe and 2 VSP locations. A soil-gas survey and surface soil sample collection will be conducted on the soils below the pavement and subgrade material on a 10-foot grid, resulting in 5 sample locations (Figure 6-6) Samples collected during the soil-gas survey will be analyzed for the compounds of interest listed on Table 6.2. The surface soil samples collected will be analyzed for TAL metals.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination. Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled. Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6 5 14 Radioactive Site (IHSS 150.6 & 150.8)

Surface materials were affected at this IHSS due to a spilled waste drum and subsequent spreading of the spill by someone walking through the spill and tracking it around Building 779 The drum contained waste oil contaminated with radioactive waste

Stage 1 activities as described in Section 6.4.1 will be performed as required to enhance subsequent stage investigations As part of the stage 1 efforts, the pavement history of this site should be resolved if possible

Stage 2 investigations will include conducting a radiological survey on a 25 to 50-ft grid resulting in 9 HPGe and 4 VSP locations A soil-gas survey and surface soil sample collection will be conducted on the soils below the pavement and subgrade materials on a 50-foot grid, resulting in 10 sample locations (Figure 6-9). Samples collected during the soil-gas survey will be analyzed for the compounds of interest listed in Table 6.2 The surface soil samples collected will be analyzed for SVOCs and TAL metals.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled Additionally, TM 2 will specify the analyses required for the soil and groundwater samples collected in the soil borings. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6 5.15 Radioactive Site (IHSS 150 7)

Surface materials were affected at this IHSS due to the 1969 fire and related fire-fighting activities The contaminant of concern is most likely plutonium

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations

Stage 2 investigations will include conducting a radiological survey on a 30-ft grid resulting in 26 HPGe and 5 VSP locations (Figure 6-6)

Stage 3 will include the installation of soil boring(s) for confirmation and/or assessment of nature and extent of contamination. TM 2 will specify the number and location of soil borings to be drilled if soil borings are required Additionally, TM 2 will specify the analyses required for the soil samples collected in the soil borings Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6 5.16 Fuel Oil Leak (IHSS 151)

Surface and subsurface materials were affected by No. 2 diesel due to a number of aboveground releases.

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations As part of the document review process, pressure test or tank inspection records need to be reviewed to see if the tank has recently been tested and what the latest test results were (i.e are tank inspections up-to-date)

Stage 2 investigations will include a soil-gas survey and collection of surface soil samples on a 25-foot grid resulting in 5 sample locations (Figure 6-8). The samples collected during the soil-gas survey will be analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX). The soil samples will be analyzed for total petroleum hydrocarbons (TPH)-Diesel Inspection of aboveground pipes, valves, etc. will be conducted Also, a pressure test will be conducted to assess the present integrity of the tank and ancillary lines if the records are out of date or incomplete

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for assessment of nature and extent of underground contamination Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled, and the analyses required for the soil and groundwater samples collected in the soil borings. Currently, it is suggested that these samples be analyzed for TPH-Diesel and BTEX Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6 4 4.2. TM 2 will also specify if the UST needs to be removed and soil samples collected within the tank pit to assess contaminant removal. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5.17 Radioactive Site (IHSS 163.1)

The ground surface may have been contaminated with nitric acid, low levels of unspecified radionuclides, and unspecified organic and inorganic contaminants. General Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations

Stage 2 investigations will include conducting a radiological survey on a 40-ft grid resulting in 7 HPGe and 3 VSP locations Also, a soil-gas survey will be performed and surface soil samples will be collected on a 50-foot grid, resulting in 9 sample locations (Figure 6-10) Soil samples will be analyzed for TPH, TAL metals, and nitrate; and samples collected during the soil-gas survey will be analyzed for the compounds of interest listed in Table 6.2.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled and the analyses required for the soil and groundwater samples collected in the soil borings. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4 4.2 TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5.18 Radioactive Site (IHSS 163 2)

The subsurface may have been contaminated with americium and plutonium due to the burial of a contaminated concrete slab Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations

Stage 2 investigations will be conducted in an effort to determine the location of the buried slab. These efforts will include conducting a ground penetrating radar (GPR) survey and possibly a magnetometer survey (assuming that the slab has been reinforced with rebar)

Stage 3 will include the installation of soil boring(s) and/or test pits as an effort to locate the slab, provided the Stage 2 efforts failed, and/or to assess nature and extent of subsurface contamination. TM 2 will specify the number and location of soil borings to be drilled and the analyses required for the soil samples collected Currently it is recommended that the soil samples be analyzed for americium and plutonium Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section

6 4 4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling

6.5.19 Central Avenue Waste Spill (IHSS 172)

The surface has been contaminated with plutonium-tainted oil and oils with lathe coolant (70 percent hydraulic oil and 30 percent CTET) due to the transportation of a leaking drum (resulting from sloshing of the drum contents through an improperly sealed bung) along Central Avenue.

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations. As part of the document review, an attempt will be made to clarify the paving history of the contaminated section of the roadway, and investigate the location of the old ditch.

Stage 2 investigations will include conducting a radiological survey using NaI probe on a 30-ft grid, resulting in 460 locations, along the ditches on either side of the roadway and on the roadway The results will be interpreted and contoured. If hot spots are detected, it will be at these locations that the HPGe will used to confirm and quantify the NaI results and determine speciation. Vertical soil profile samples will be collected below the pavement and subgrade materials following the HPGe survey at locations determined by the survey results. TM 2 will provide the survey results and a basis for any additional sampling that may be required.

6.5.20 Radioactive Site (IHSS 173)

The surface has been contaminated with plutonium, uranium, beryllium, acetone, and other unspecified solvents due to accidental releases at a dock area and cleaning of depleted uranium parts.

Stage 1 activities as described in Section 6 4 1 will be performed as required to enhance subsequent stage investigations.

Stage 2 investigations will include conducting a radiological survey on a 30-ft grid resulting in 1 HPGe and 2 VSP locations. Also, surficial soil sampling and a soil-gas survey will be conducted on a 25-foot grid, resulting in 3 sample locations (Figure 6-13) The surficial soil samples will be analyzed for TAL metals and samples collected during the soil-gas survey will be analyzed for the compounds of interest listed in Table 6.2.

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or to assess nature and extent of subsurface contamination. Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled and the analyses required for the soil and groundwater samples collected. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4 4.2 TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5.21 Radioactive Site (IHSS 184)

The surface may have been contaminated with unspecified radioactive contaminants due to steam cleaning equipment and drums

Stage 1 activities as described in Section 6 4.1 will be performed as required to enhance subsequent stage investigations As part of the Stage 1 review, the pavement history for the paved area between Building 992 and the south dock will be investigated. As part of the site visit, the integrity of the concrete floor and sump will be investigated.

Stage 2 investigations will include conducting a radiological survey on a 30-ft grid on the concrete floor, at the outfall location, and 400 feet down slope in the unlined ditch southeast of the building resulting in 3 HPGe and 1 VSP locations A radiological survey will also be conducted on a 30-ft grid with collection of 1 VSP sample in the paved area between Building 992 and the south dock (Figure 6-13). If it is determined from Stage 1 activities that the concrete floor and/or sump is cracked, the radiological survey will be conducted in appropriate areas.

Stage 3 will include the installation of soil boring(s) for confirmation and/or to assess nature and extent of subsurface contamination TM 2 will specify the number and location of soil borings to be drilled and the analyses required for the soil samples collected. Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling.

6.5 22 Acid Leak (IHSS 188)

The surface has been contaminated with waste metal leaching solution containing hydrochloric and nitric acids and trace amounts of heavy metals due to a release from a 55-gallon drum.

Stage 1 activities as described in Section 6.4.1 will be performed as required to enhance subsequent stage investigations As part of the Stage 1 review an attempt will be made to determine what metals may have been present in the release.

Stage 2 investigations will include collecting surficial soil samples of the soil below the pavement and subgrade materials on a 50-foot grid, resulting in 5 sample locations (Figure 6-8). The surface soil samples will be analyzed for nitrate, Ph and TAL metals

Stage 3 may include additional surficial soil sampling and will include the installation of soil boring(s) for confirmation and/or to assess nature and extent of subsurface contamination Also, groundwater samples will be collected via the BAT® sampler if groundwater is encountered. TM 2 will specify the number and location of soil borings to be drilled and the analyses required for the soil and groundwater samples collected Also, soil samples will be collected from the soil borings for analysis of geophysical and geochemical properties as described in Section 6.4.4.2. TM 3 will provide the basis for any additional sampling that may be required beyond Stage 3 sampling

6 6 AIR SAMPLING PROGRAM

6.6.1 Existing Resources

Characterization of ambient air quality at OU8 will require compilation of relevant existing data and collection of additional data to fill informational gaps. The relevant meteorological data collected from the RFP monitoring station include wind speed, wind direction, sigma theta, temperature, relative humidity, and precipitation. Hourly averages of these data are required for performance of air quality impact analysis. The wind data should be used to generate daily wind roses. Daily summaries of the other parameters will be required. A continual review of existing data that pertains to assessment of OU8 air quality should be conducted as part of the Work Plan. These reviews should include comparison of ambient air contaminant concentrations derived from previous modeling or monitoring programs

Data use objectives require ambient air concentrations and distributions of the individual contaminants on and off the site The existing ambient air monitoring program offers the spatial resolution necessary to meet these objectives for airborne plutonium, americium, and particulate material emitted from RFP as a whole. The existing monitoring stations located near individual IHSS sites will typically offer only limited support in definition of OU8 IHSS air pathways. This

IHSS-specific support can be maximized by coordinating individual monitor operation schedules and correlating the collected data to IHSS site field activities and existing site conditions. Isopleth maps can then be developed as necessary to establish maximum and mean exposure levels on the site and quantify the off-site transport of contaminants.

Monitoring station locations should be selected on the basis of the dominant wind patterns at the site. Since the plumes from IHSSs will be directed by the wind, locating monitors downwind will allow sampling of the plumes. The primary wind direction is northwesterly. Additional stations should be positioned to monitor concentrations when the winds are not from the primary direction.

There are six ambient air monitoring stations of interest to this investigation. These six samplers encircle the OU and should provide representative airborne particulate samples both upwind and downwind (according to prevailing area wind patterns). The specific ambient air monitoring sites suitable for data review when defining OU8 IHSS air pathways include S-1, S-3, S-5, S-17, S-20, and S-21. With respect to prevailing wind patterns at RFP, S-3 and S-21 (or alternatively, S-4 and S-16) would generally represent upwind conditions while S-1, S-5, S-17, and S-20 represent downwind conditions relative to OU8 Additional monitoring stations that might contribute to downwind IHSS-specific air pathway definition include S-2, S-6, S-8B, and S-19 It should be noted that S-5 and S-6 have historically provided the highest area plutonium concentrations (Section 5.1, Table 5.6). It must also be remembered that all monitoring site measurements represent multiple RFP sources and may provide upwardly-biased information with regard to a specific OU8 IHSS. Similarly, IHSSs located closely to an operational downwind monitor would provide more reliable data than one situated a long distance upwind.

6.6.2 Additional Data Collection

Localized air monitoring may be performed during field activities to ensure that quality data are obtained during sampling. All sampling activities should be performed in compliance with the RFP PPCD and in accordance with OP FO 1, Air Monitoring and Dust Control

Whenever implemented, area air quality monitoring requirements would be conducted during activities such as when borehole drilling and soil-gas surveys are performed or when significant potential for production of appreciable quantities of airborne particulates or release of volatile organic materials is possible These requirements include

- Continued operation and monitoring of the Site Perimeter and Community RAAMP. Six of these samplers (S-1, S-3, S-5, S-17, S-20, S-21) are located within or immediately adjacent to OU8 and will be relied upon to characterize the local area air pathway

- Local monitoring of Respirable Suspended Particulates (RSP) at individual activity work sites using real-time respirable aerosol mass monitors Local RSP measurements will be employed to guide the project manager's evaluation of the potential hazards associated with work activity-related emissions. The threshold RSP concentration for curtailing intrusive activities will be 6.0 mg/m^3.

- Additional worker health and safety monitoring as required by the Site-Specific Health and Safety Plan (SSHSP). This includes initial area radiation surveys intended to identify possible radiation hazards that could be associated with airborne particulates and site monitoring for volatile organics using Hnu or OVA.

Soil-gas surveys are planned for select IHSSs believed containing VOCs. This data can: (1) Identify areas of higher than average soil-gas contaminant content and their movements, (2) Serve as model inputs (source terms) to estimate ambient air concentration under changing meteorological conditions, and (3) Estimate uncontrolled emissions levels during invasive site operations. These VOCs would have the potential to be released to the atmosphere during actual sample acquisition or as an emission from completed instrumentation (i e., well headspace) This information can be coupled with indirect portable ambient air monitoring data collected in accordance with the SSHSP to help understand the potential impacts attributable to individual IHSSs

6 7 PHASE I RFI/RI REPORT

An internal draft RFI/FI report will be prepared after the evaluation of all field data is complete and all analytical data have been received and reviewed The report will document the field activities, technical procedures and results of the investigation at OU8 For each IHSS, to the extent possible, tabular summaries of analytical results and contaminant concentration contour maps will be included to define the nature and extent of any observed contamination The report will provide recommendations for any additional field investigation that may be required.

Three versions of the RFI/RI report will be prepared. First, an Internal Draft RFI/RI report will be prepared and submitted. Following review and receipt of comments from DOE, a Draft RFI/RI Report will be prepared and submitted for review by the regulatory agencies Following review of the document and incorporation of all comments provided by regulators, a Final RFI/RI report will be prepared and issued.

The RFI/RI report will include both a HHRA and an EE. The HHRA and EE will evaluate any "no-action" alternative based on current conditions at each IHSS within OU8 that was investigated during implementation of this Work Plan. Information about potential chemical releases, routes of exposure points, and the assessment of health risks developed for the non-action alternatives is used as a basis for determining the need and extent of any proposed remedial alternatives that may be required Separate RAs will be prepared for each IHSS or group of IHSSs. The HHRA and EE will be conducted in accordance with HHRA and EE plan outlined in Section 8.0 and Section 9.0, respectively.

This HHRA and EE are integral parts of the RFI/RI report and will be submitted simultaneously. It will assist in evaluation of potential remedial alternatives including "no action" remediation that satisfies existing ARARS, and remediation that does not meet existing ARARS but may nevertheless constitute a satisfactory approach to management of the site. Remedial objectives will be recommended that may be used to support a specific approach for each IHSS if an IHSS-specific approach is required If more appropriate, a general approach addressing the entire OU or groups of IHSSs will be recommended The remedial objectives recommended will be health-protective and cost-effective.

6 8 SAMPLE COLLECTION AND ANALYSIS

The purpose of this section is to develop field sample collection and analysis methods. These methods would then be applied to the sampling requirements presented in Section 11 4 by providing procedures for sampling tasks and identifying analytical levels and methodologies.

6.8 1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the RFEDS. Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings, "SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "AS" for Advanced Sciences) One sample number will be required for each sample generated, including QA/QC samples. A similar sample designation system will be used for samples collected during the field screening task including soil gas results, soil and ground water screening results, and radiological surveys. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the data base. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU8 Boring numbers will be developed independently of the sample numbers for a given boring and are assigned by EG&G with appropriate cross-references These sample numbering procedures are consistent with the RFP QAPjP. If input requirements for the RFEDS system have changed from the above listed, the most current system will be used.

6 8.2 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance describing container labeling, decontamination, field packaging, chain-of-custody records, field data documentation, packaging, and shipping is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples (EG&G, 1992c).

The field data and reporting requirements are discussed in detail in the SOP FO.14, Field Data Management (EG&G, 1992c). In general the following procedures must be followed:

- Collection of data on pre-printed forms,
- Preliminary verification of the data;
- Technical verification by a qualified verifier;
- Data input into the RFEDS;
- Verification of input;
- Archiving and filing of data;
- Security of database and computers;
- Documentation of implementation of the referenced SOP, and

- Use of data management forms

6 8 3 Sample Containers and Preservation

The type of analysis and media to be sampled dictates the sample container volume and material requirements, preservation techniques, and holding times The parameters specific to OU8 with the corresponding containers, preservative, and holding time are listed in Table 6 6 Additional specific information relating to sample containers and preservatives is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples (EG&G, 1992c)

6.8 4 Field QA/QC Procedures

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the EMD project manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their application are discussed below The frequency with which QC samples will be collected and analyzed is provided in Table 6.7 and Section 10.0.

Duplicate samples will be collected by the sampling team for use as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures and equipment, and placed in the same types of containers as required for the samples They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field blanks of distilled water will be prepared by the sampling team and will be used to provide any indication of any contamination introduced during field preparation.

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on non-dedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection The rinsate is collected and placed in the appropriate sample containers

Trip blanks consisting of distilled water will be prepared by the laboratory technician and will accompany each shipment of samples for VOC analysis Trip blanks will be stored with the group of samples with which they are associated Analysis of the trip blank will indicate migration of VOCs or any problems associated with sample shipment, handling, or storage. Information from the trip blanks will be used in conjunction with air monitoring data and other information to assess the influence of ongoing waste operations on the quality of data collected.

6.8.5 Prevention of Contaminant Spreading

Contaminants can be introduced into adjacent media that was previously not contaminated as a result of soil disturbance and airborne/surface water transport, smearing of the soil profile, venting of volatile compounds from the subsurface, and cross connection of water-bearing zones The drilling of boreholes is one activity that may cause cross contamination of adjacent media. In order to minimize the likelihood of contamination spreading the appropriate SOPs will be followed during drilling procedures.

The procedures for borehole soil sampling are outlined in.

- SOP GT.17 <u>Land Surveying</u>,
- SOP GT.10 <u>Borehole Clearing</u>,
- SOP FO.03 <u>General Equipment Decontamination</u>,
- SOP FO.04 <u>Heavy Equipment Decontamination</u>,
- SOP GT.02 <u>Drilling and Sampling Using Hollow Stem Auger Techniques</u>,

- SOP GT.01 Logging Alluvial and Bedrock Material,
- SOP FO 08 Handling Drilling Fluids and Cuttings,
- SOP GT.05 Plugging and Abandonment of Boreholes,
- SOP FO.09 Handling of Residual Soil Samples, and
- SOP FO.18 Environmental Sample Radioactive Content Screening (EG&G 1992c and EG&G, 1992d)

Localized air monitoring will be performed during field activities to ensure that quality data are obtained during sampling All sampling activities will be performed in compliance with the RFP PPCD and in accordance with SOP FO 1, Air Monitoring and Dust Control (EG&G, 1992c)

In the case that contamination is being dispersed through air pathways in significant amounts as determined by monitoring outlined in Section 6, activities will be stopped until appropriate measures can be applied.

Soil-gas surveys will be performed as identified in Section 6 4.2. Soil-gas data will be collected for select OU8 IHSSs that appear to be potentially contaminated with volatile organic contaminants. These VOCs do have the potential to be released to the atmosphere during actual sample acquisition or as an emission from completed instrumentation (i e., well headspace). Worker health and safety monitoring will be performed for these potential hazards as required by the SSHSP.

The procedures for installation of groundwater monitoring wells are previously outlined under borehole soil sampling procedures (EG&G 1992c and EG&G 1992d).

6 8.6 Analytical Requirements

As discussed in Section 6, analytical parameters are based on the rationale that the operational history and release history are not clearly defined. In general, initial soil and groundwater samples will be analyzed for the following chemical and radionuclide parameters

- Target Analyte List (TAL) Metals,
- Total Organic Carbon (TOC),
- Total Petroleum Hydrocarbons (TPH),
- Target Compound List (TCL) Volatiles,
- Target Compound List (TCL) Semi-volatiles,
- Radionuclides,
- Anions,
- Ph, and
- Specific conductance.

Field measurement of temperature, Ph, and specific conductance will be taken on groundwater samples obtained in accordance with SOP GW.05 Field Measurement of Groundwater Field Parameters and SOP GW.06 Groundwater Sampling (EG&G 1991a).

The OU8 analytical parameter list may be modified for some IHSSs based on the results of additional data compilation activities in Section 6.0. Later stage analytical parameters will focus on only those contaminants identified in the earlier stages. Decisions regarding analytical parameter selection will be documented by submitting Technical Memoranda.

6.9 DATA MANAGEMENT AND REPORTING

Field data will be input to the RFEDS using a DATACAP remote data entry module supplied by EG&G. Data will be entered on a daily basis, and a 3.5-inch computer diskette will be delivered to EG&G on a weekly basis EG&G updates RFEDS on a weekly basis. Data from the system will be available to the contractor immediately after the weekly update. A hard copy report will be generated from the module for contractor use. The data will undergo a prescribed QC process based on EMD SOP FO.14

The contractor will maintain a data base for field data that is collected during screening tasks. The contractor will provide 3.5-inch diskettes and hard copies to EG&G for their use.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate timely reporting of information These data will also be delivered to EG&G on 3.5-inch computer diskettes. Computer hardware and software requirements for contractors using government-supplied equipment will be supplies by EG&G. Computer and data security measures will also follow acceptable procedures outlined by EG&G. The RFEDS system is evolving Data management will follow the procedures in effect at the time this field work is implemented.

6 10 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND ADDENDUM

All work conducted in support of OU8 Phase I RFI/RI activities will be directed by the EG&G Environmental Management Department Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facilities Investigation/Corrective Measures Study Activities (QAPjP) The QAPjP complies with the requirements of EPA QAMS-005/80 and DOE Order 5700.6B and 5700 6C.

The QAPjP will be supplemented by a Quality Assurance Addendum (QAA) specific to OU8. The QAA will be provided by EG&G for inclusion in the Work Plan after EG&G completes review of the Draft Work Plan The QAA will establish the specific Quality Assurance controls applicable to the field investigation activities described in the OU8 Work Plan.

69/100

Table 6.1

Summary of Standard Operating Procedures to Be Used for Implementation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
118 1	Soil gas Survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.09, Soil Gas Sampling and Field Analysis SOP.GT.19 Field Gas Chromatographies. SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Cleaning SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW 03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
118.2	Soil gas Survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.09, Soil Gas Sampling and Field Analysis SOP.GT.19 Field Gas Chromatographies. SOP GT 01 Logging Alluvial and Bedrock Material SOP GT 02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Cleaning SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling 118.2 Soil gas Survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling SOP SW.03 Surface Water Sampling SOP SW 04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

70/100

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
123 1	Radiological survey Surfacial soil sampling Soil gas survey XRF Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.08, Surface Soil Sampling SOP GT.09, Soil Gas Sampling and Field Analysis SOP GT.19 Field Gas Chromatographies. SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
135	Radiological survey Surficial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.08, Surface Soil Sampling SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT 05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW 03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

71/100

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
137	Surfacial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT 08, Surface Soil Sampling SOP GT 01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
138	Radiological survey Surficial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.08, Surface Soil Sampling SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
139 1	Surfacial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Groundwater Sampling Surface-water and sediment sampling	SOP GT.08, Surface Soil Sampling SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT 05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP GW 06 Groundwater Sampling SOP SW 03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
139 2	Surfacial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT 08, Surface Soil Sampling SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Cleaning SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW 03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
144	Collecting sediment samples Soil gas survey Radiological survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.09, Soil Gas Sampling and Field Analysis SOP GT.19 Field Gas Chromatographies. SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.01 Logging Alluvial and Bedrock Material SOP GT 02 Drilling and Sampling Using Hollow Auger Techniques SOP GT 05 Plugging and Abandonment of Boreholes SOP GT 10 Borehole Cleaning SOP GT 17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO 13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

73/100

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
150.1	Radiological survey Soil gas survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterization for Radionuclides SOP GT.09, Soil Gas Sampling and Field Analysis SOP GT.19 Field Gas Chromatographies. SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
150.2	Radiological survey	SOP GT.30 In Situ Characterization for Radionuclides
150 3	Radiological survey Soil gas survey Soil Boring (geochemical & geophysical sample collection) Surface-water and sediment sampling	SOP GT 30 In Situ Characterization for Radionuclides SOP GT.09 Soil Gas Sampling or Field Analysis SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT 10 Borehole Clearing SOP GT.17 Land Surveying SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

74/100

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
150 4	Radiological survey Surfacial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.08, Surface Soil Sampling SOP GT.09 Soil Gas Sampling or Field Analysis SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT 10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
150 6/ 150 8	Radiological survey Surfacial soil sampling Soil Gas Survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.08, Surface Soil Sampling SOP GT.09 Soil Gas Sampling or Field Analysis SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT 05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
150 7	Radiological survey Soil Boring (geochemical & geophysical sample collection) Surface-water and sediment sampling	SOP GT.30 In Situ Characterization for Radionuclides SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
151	Surfacial soil sampling Tank/pipeline inspection Tank residue sampling Soil Gas Survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT. 08 Surface Soil Sampling SOP GT.09 Soil Gas Sampling or Field Analysis SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

76/100

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
163.1	Radiological survey Surfacial soil sampling Soil Gas Survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterzation for Radionuclides SOP GT.08, Surface Soil Sampling SOP GT.09 Soil Gas Sampling or Field Analysis SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW 03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
163.2	Ground penetrating radar survey magnetometer survey Soil Boring (geochemical & geophysical sample collection) Surface-water and sediment sampling	SOP GT. 18 Surface Geophysical Surveys SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP SW.03 Surface Water Sampling SOP SW.04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
172	Radiological survey Surfacial soil sampling Surface-water and sediment sampling	SOP GT.08, Surface Soil Sampling SOP SW 03 Surface Water Sampling SOP SW 04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

77/100

Table 6.1
(Continued)

Summmary of Standard Operating Procedures to Be Used for Implemmentation of Stages 2 and 3 of the OU8 Phase I RFI/RI FSP

IHSS	Investigative Technique	Applicable Guidance Procedures
173	Radiological survey Soil gas survey Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT.30, In Situ Characterization for Radionuclides SOP GT.09 Soil Gas Sampling and Field Analysis SOP.GT 19 Field Gas Chromatographies. SOP GT 01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT.05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT.17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW 03 Surface Water Sampling SOP SW 04 Sediment Sampling SOP FO.13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
184	Radiological survey Soil Boring (geochemical & geophysical sample collection) Surface-water and sediment sampling	SOP GT.30, In Situ Characterization for Radionuclides SOP GT.01 Logging Alluvial and Bedrock Material SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT 05 Plugging and Abandonment of Boreholes SOP GT.10 Borehole Clearing SOP GT 17 Land Surveying SOP SW.03 Surface Water Sampling SOP SW 04 Sediment Sampling SOP FO 13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples
188	Surficial soil sampling Soil Boring (geochemical & geophysical sample collection) BAT® Sampling Surface-water and sediment sampling	SOP GT 08, Surface Soil Sampling SOP GT.01 Logging Alluvial and Bedrock Material SOP GT 02 Drilling and Sampling Using Hollow Stem Auger Techniques SOP GT 05 Plugging and Abandonment of Boreholes SOP GT 10 Borehole Clearing SOP GT 17 Land Surveying SOP GT.22 In-Situ Sampling With BAT Sampling SOP SW 03 Surface Water Sampling SOP SW 04 Sediment Sampling SOP FO 13 Containerization, Preserving, Handling and Shipping of Soil and Water Samples

78/100

Table 6.2

Compounds of Interest for Portable GC Calibration

IHSS	COMPOUND OF INTEREST
118.1	Carbon Tetrachloride (CTET)
118 2	CTET, Benzene, Dichloromethane, 1,1,1-Trichloroethane (TCA), and Methylethylketone (MEK)
123.1	Benzene, Toluene, Xylene, Perchloroethene (PCE), and Trichloroethene (TCE)
135	NA
137	NA
138	NA
139 1(N) & 139.1(S)	NA
139.2	NA
144(N) &144(S)	CTET, 1,1,1-TCA, benzene, Toleuene, Xylene, MEK, Dichloromethane, PCE, and TCE
150.1	1,1-DCA, PCE, TCE, CTET, Benzene, Toluene, Xylene
150.2	NA
150.3	PCE, TCE, CTET, benzene, toluene and xylene
150 4	Acetone, 1,1-DCE and CTET
150 6 & 150 8	PCE, TCE, CTET, benzene, toluene and xylene
150 7	NA
151	Benzene, toluene, ethylbenzene, and xylene
163 1	TCE, PCE, Benzene, Toluene, and Xylene
163.2	NA
172	NA
173	Acetone, PCE, CTET, and TCE
184	NA
188	NA

Peaks for other compounds will be noted. The GC will be recalibrated and a split sample run for those peaks.

Table 6.3

Summary of Phase I Investigation Stages for OU8

Activity	Purpose	Location	Sample Number
<u>Stage 2</u>			
HPGe Radiation Survey	Identify areas of anomalous gamma ray radiation readings.	Entire IHSS area for IHSSs: 123 1, 138, 150 1, 150 2, 150.3, 150 4, 150 6 & 150.8, 150.7, 163.1, 172[1], 173, 184.	IHSS dependent
Sodium Iodide Probe Radiation Survey	Identify areas of anomalous radiation readings	IHSS dependant.	IHSS dependent.
Vertical Soil Profiles	Aid interpretation of HPGe survey.	Locations selected after HPGe survey completed.	Minimum of two per IHSS
Soil-Gas Survey	Locate VOC anomolies.	Entire IHSS area on a grid, grid spacing IHSS dependent, includes IHSSs: 118.1, 123.1, 138, 144(N), 144(S), 150.1, 150 3, 150 4, 150 6 & 150 8, 151, 163.1, 173.	IHSS dependent

[1] Only hot spots identified with the NaI probe will be investigated using the HPGe, not the entire IHSS area.

79/100

Table 6.3
Summary of Phase I Investigation Stages for OU8

Activity	Purpose	Location	Sample Number
Stage 2 (Continued)			
Surficial Soil Sampling	Locate non-radiological and radiological surface anomolies and assess analytical data variability	Entire IHSS area on a grid, grid spacing IHSS dependent, includes IHSSs 118 2, 123.1, 135, 137, 138, 139 1(N), 139 1(S), 139 2, 144(N), 144(S), 150 1, 150 3, 150 4, 150 6 & 150 8, 151, 163 1, 173, 188	IHSS dependent
Tank and Pipeline Inspection	Establish tank and ancillary equipment integrity	IHSS 151	None
Surface-water and Sediment Sampling	Identify contaminant source(s) and collect preliminary information for Phase II planning	IHSS dependent	To be determined
TECHNICAL MEMORANDUM 2	Evaluate, interpret, and present data collected during Stage 2 investigations and provide a FSP for Stage 3 activities		

Table 6.3
Summary of Phase I Investigation Stages for OU8

Activity	Purpose	Location	Sample Number
<u>Stage 3</u>			
Additional Surficial Soil Sampling	Assess nature & extent of surface contamination Further characterize contamination found in Stage 2	IHSS dependent (defined in technical memorandum)	To be determined by statistical analysis
Soil Borings & BAT® Sampling	a Assess natute and extent of subsurface contamination.	IHSS dependent.	To be determined
	b Characterize subsurface contamination and vadose zone conditions		
	c Transect and sample anomolies identified by Stage 2 activities.		
	d Assess presence/absence of and characterize groundwater contamination.		
TECHNICAL MEMORANDUM 3	Evaluate, interpret, and present data collected during Stage 3 investigations and provide a FSP for Stage 4 activities		

81/100

Table 6.3
Summary of Phase I Investigation Stages for OU8

Activity	Purpose	Location	Sample Number
<u>Stage 4</u>			
Additional Soil Borings & BAT® Sampling	Fully define extent of contaminants in the subsurface	Based on previous investigations	To be determined
Leachability Testing	Determine transport characteristics of the contaminant, and provide information for Phase II	To be determined.	To be determined
Soil Tensiometer Nest Installation	Determine transport characteristics of the vadose zone.	To be determined	To be determined
Piezometer Installation	Obtian information on the local hydraulic gradient and groundwater flow regime to determine potential for groundwater contamination.	To be determined	To be determined
TECHNICAL MEMORANDUM 4	Evaluate, interpret, and present data collected during Stage 4 investigations and provide a FSP for Stage 5 activities		
<u>Stage 5</u>			
Groundwater Monitoring Well Installation	Assess nature and extent of groundwater contamination	To be determined	To be determined

82/100

83/100

Table 6.4

Summary of Sample and Survey Location Frequency

IHSS	Grid Spacing (ft)		Number of Sample Locations			
	Surface Samples and Soil Gas	HPGe	Surface Soil Samples	Soil Gas	HPGe	Vertical Soil Profile Samples
118.1	25	-0-	-0-	7	-0-	-0-
118.2	10	-0-	-0-	7	-0-	-0-
123.1	50	30	9	9	14	4
135	50	-0-	5	-0-	-0-	-0-
137	50	-0-	7	-0-	-0-	-0-
138	25	30	9	-0-	4	2
139.1 (N)	25	-0-	8	-0-	-0-	-0-
139.1 (S)	25	-0-	3	-0-	-0-	-0-
139.2	25	-0-	3	-0-	-0-	-0-
144 (N)	25	-0-	5	5	-0-	-0-
Area east of 144 (N)	25	30	3	-0-	1	1
144 (S)	25	-0-	7	7	-0-	-0-
150.1	50	40	10	10	12	4
150.2	-0-	65	-0-	-0-	10	4
150.3	25	30	7	7	7	3
150.4	10	30	5	5	1	2
150.6 & 8	50	25 to 50	10	10	9	4
150.7	-0-	30	-0-	-0-	26	5
151	25	-0-	5	5	-0-	-0-
163.1	50	40	9	9	7	3
163.2	-0-	-0-	-0-	-0-	-0-	-0-
172	-0-	30[1)]	-0-	-0-	460[1)]	TBD
173	25	30	3	3	1	2
184	-0-	30	-0-	-0-	3	2
188	50	-0-	5	-0-	-0-	-0-

TBD = To be determined

1) NaI survey

Table 6.5

Phase I Analytical Program

IHSS	Type of Contamination: Acids	Solvents	Fuels/ Oils	Anions	Metals	Radionuclides	Geophysical Surveys	HPGe and Vertical Profile Samples	NaI Probe Survey	Soil Gas Analyses	Surface Soil Analyses: TPH	SVOCs	Metals	Total Chromium	Nitrate	Fluoride	Tritium	RADS	pH
[illegible]		R								•									
118.2		RH								•									
[illegible]	R	R	R	R	R	R		•		•		•	•		•	•			
135				R	R	R								•			•		
[illegible]				R	R			•						•					
136					RHS	RHS								•					
[illegible]				RH															•
139.2	HR														•				•
[illegible]		HR			RH	RHS		•		•		•	•					•	
150.1	HR	HR			HR	VR		•		•		•	•						
[illegible]						R		•											
150.3		R			R	R		•		•		•	•						
[illegible]		R			R	RH		•		•		•	•						
150.6 & 150.8		R				R		•		•		•	•						
[illegible]						R		•											
161			RHS							•	•								
[illegible]	HR	HR		HR	HR	HR		•		•	•		•		•				
163.2						HRS	•												
[illegible]		R	R			R		•	•										
173		HR			HR	HR		•		•									
[illegible]						HR		•											
189	R				R									•	•				•

Key
H - Historical storage information
R - Documented release information
S - Sample analysis information

84/100

Table 6.6

Sample Containers, Preservation, and Holding Times for Residue, Soil, and Water Samples

RESIDUE AND SOIL SAMPLES

Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 250 ml wide-mouth glass jar	Cool, 4° C	180 days
Cyanide	1 x 250 ml wide-mouth glass jar	Cool, 4° C	14 days
TCL Volatiles	2 x 125 ml wide-mouth, Teflon-lined jar	Cool, 4° C	7 days
TCL	1 x 250 ml wide-mouth	Cool, 4° C	7 days until extraction
Semivolatiles	Teflon-lined jar		40 days after extraction
Radionuclides	1 x 1l wide-mouth glass jar	None	180 days
TOC, Anions, pH, and specific conductance	1 x 250 ml wide-mouth glass jar	Cool, 4° C	28 days

WATER SAMPLES

Parameter	Container	Preservative	Holding Time
TAL Metals*	1 x 1l polyethylene bottle	Nitric acid pH<2, Cool, 4° C	180 days
Cyanide*	1 x 1l polyethylene bottle	Sodium hydroxide pH>12, cool, 4° C	14 days
TCL Volatiles*	2 x 40 ml VOA vials with teflon-lined septum lids	Cool, 4° C	7 days
TCL Semivolatiles*	1 x 4l amber glass bottle	Cool, 4° C	7 days until extraction, 40 days after extraction
Radionuclides	12l polyethylene bottle(s)	Nitric acid pH<2, Cool, 4° C	180 days
TOC	1 x 250 ml polyethylene bottle	Sulfuric acid pH<2, Cool, 4° C	28 days
Anions*	1 x 1l polyethylene bottle	Cool, 4° C	28 days
Nitrate/Nitrite*	1 x 250 ml polyethylene bottle	Sulfuric acid pH<2, Cool, 4° C	28 days
pH, temperature, and specific conductance	In-situ, beaker, or bucket	None	Analyze immediately

Holding time for mercury is 28 days

* For samples collected via the BAT® sampler a 500 mL glass manufacturer-supplied vial will be used

85/100

Table 6.7

Field QC Sample Frequency

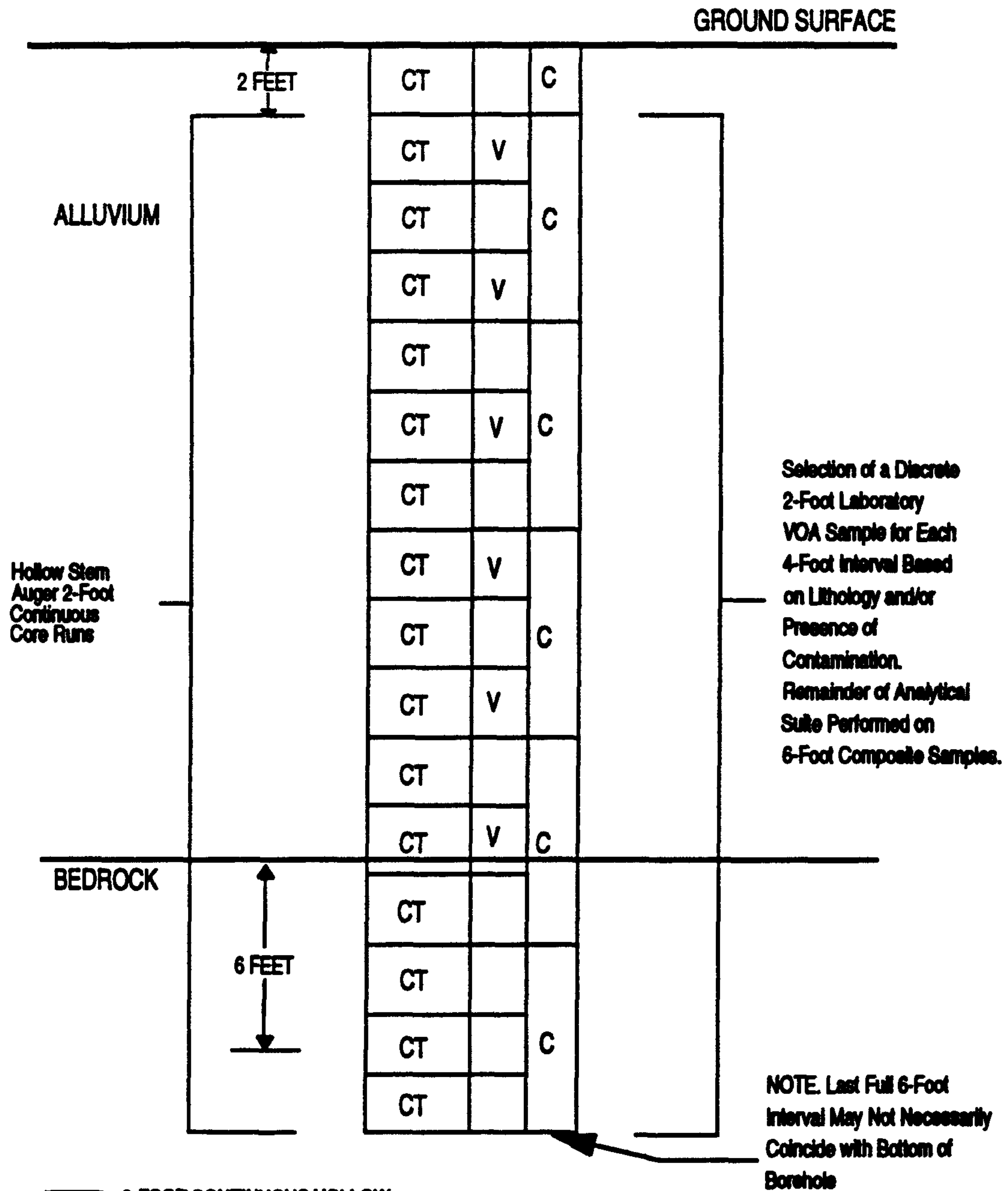
Sample Type	Type of Analysis	Sample Frequency Solids*	Sample Frequency Liquids*
Duplicates	Organics	1/20 or 1/day	1/20 or 1/day
	Inorganics	1/20 or 1/day	1/20 or 1/day
	Radionuclides	1/20 or 1/day	1/20 or 1/day
Field Banks	Organics	N/R	N/R
	Inorganics	1/20 or 1/day	1/20 or 1/day
	Radionuclides	1/20 or 1/day	1/20 or 1/day
Equipment Blanks	Organics	1/20 or 1/day	1/20 or 1/day
	Inorganics	1/20 or 1/day	1/20 or 1/day
	Radionuclides	1/20 or 1/day	1/20 or 1/day
Trip Blanks	Organics	1/20 or 1/day	1/20 or 1/day
	Inorganics	N/A	N/A
	Radionuclides	N/A	N/A

N/A = Not Applicable N/R = Not Required
1/20 = one QC sample per twenty samples collected
*QC samples will be collected on whichever identified intervals is more frequent

86/100

87/100

Typical Source Characterization Borehole in Alluvium/Bedrock



CT	2-FOOT CONTINUOUS HOLLOW STEM AUGER CORE RUN
V	LOCATION OF DISCRETE SAMPLE FOR TCL VOLATILE ANALYSIS (SAMPLE TO BE COLLECTED FROM THE BOTTOM 6 INCHES OF DRIVE SAMPLE)
C	6-FOOT COMPOSITE LABORATORY SAMPLE FOR ANALYSIS OF REMAINDER OF ANALYTICAL SUITE (2-FOOT AT THE 0-2 FOOT DEPTH INTERVAL)

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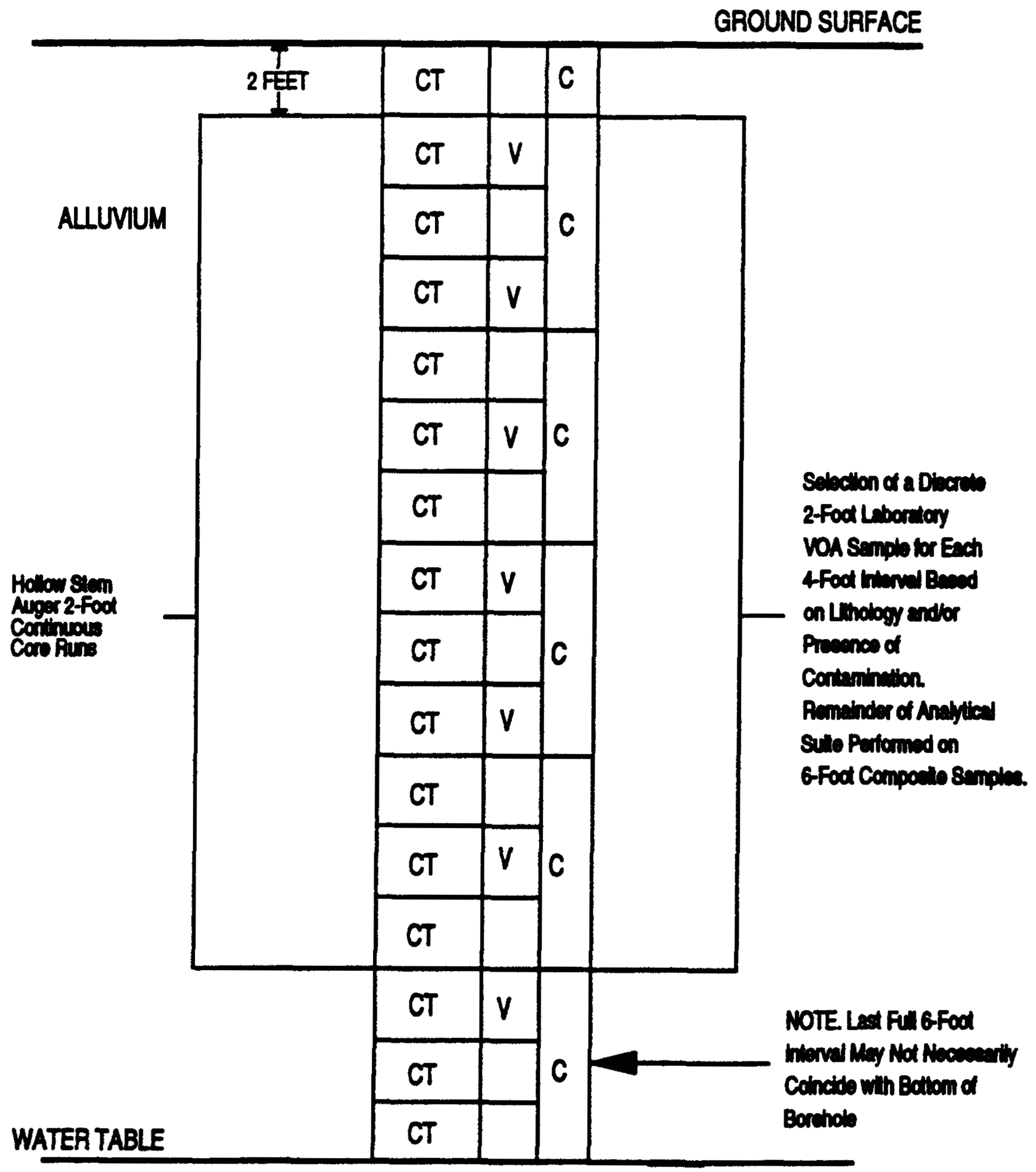
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6-1
Lithologic and Chemical Sampling for Source Characterization Boreholes in Alluvium/Bedrock

88/100

Typical Source Characterization
Borehole Above Saturated Alluvium



CT — 2-FOOT CONTINUOUS HOLLOW STEM AUGER CORE RUN

V — LOCATION OF DISCRETE SAMPLE FOR TCL VOLATILE ANALYSIS (SAMPLE TO BE COLLECTED FROM THE BOTTOM 6 INCHES OF DRIVE SAMPLE)

C — 6-FOOT COMPOSITE LABORATORY SAMPLE FOR ANALYSIS OF REMAINDER OF ANALYTICAL SUITE (2-FOOT AT THE 0-2 FOOT DEPTH INTERVAL)

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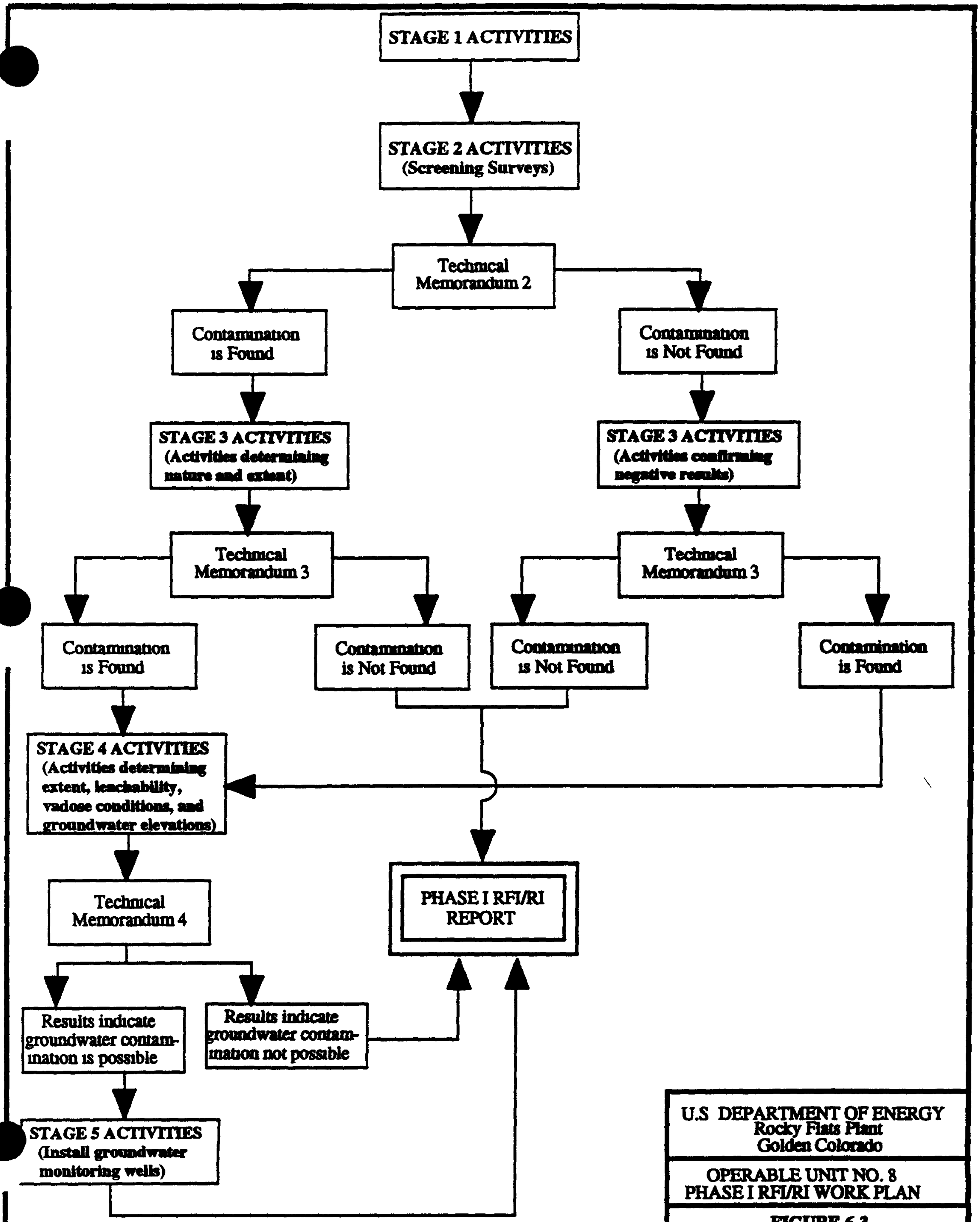
FIGURE 6-2
Lithologic and Chemical Sampling for Source Characterization Boreholes Above Saturated Alluvium



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Golden Colorado

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FIGURE 6-3

FLOW DIAGRAM FOR PHASE I RFI/RI SAMPLING

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Approved By

Manager, Remediation Programs 6/28/94

RFI Project Manager 6/28/94

7.0 PHASE I RFI/RI TASK SCHEDULE

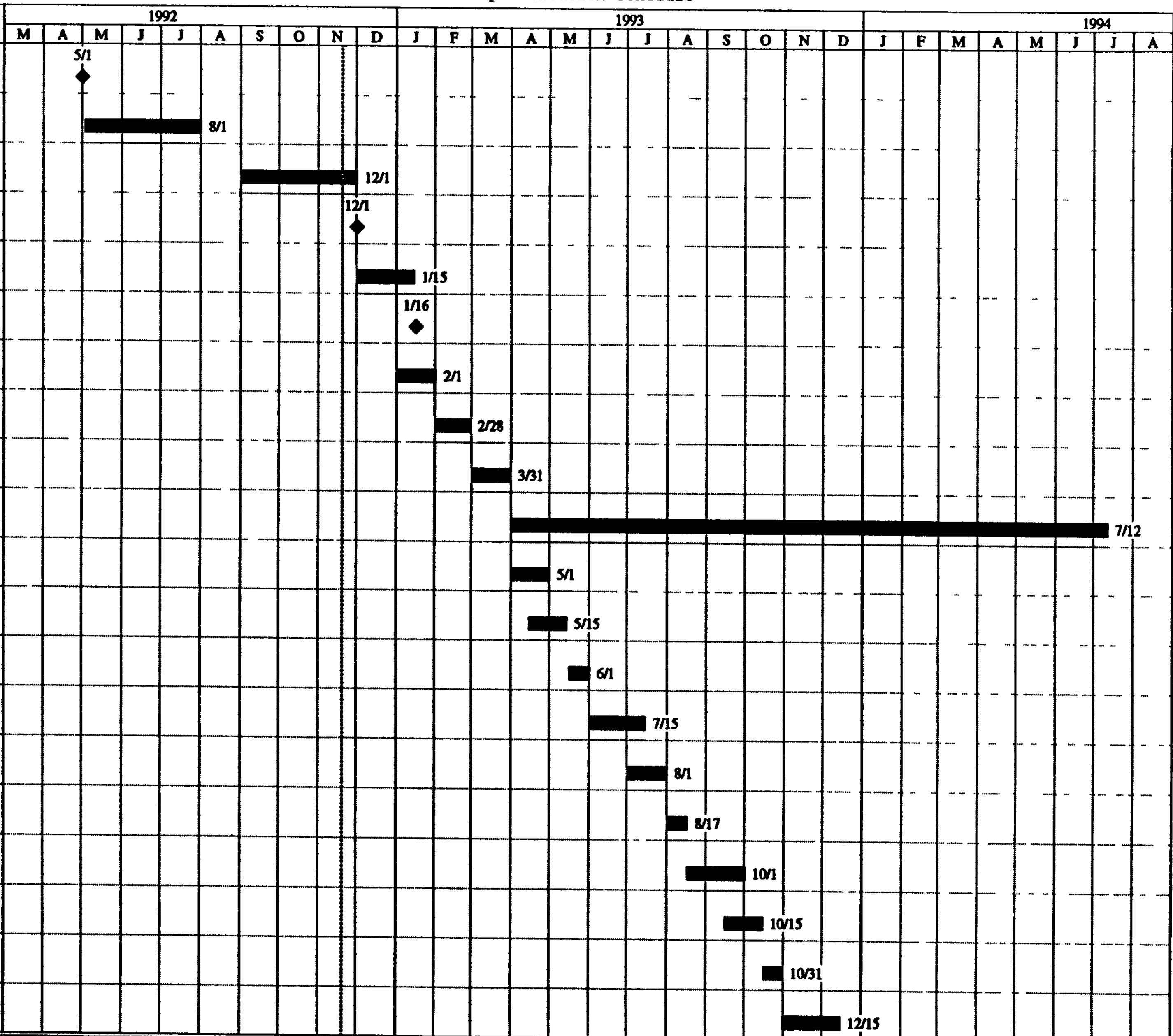
The schedule for conducting the OU8 Phase I RFI/RI is summarized in Figure 7-1. The schedule reflects these milestones established in Attachment 2, Table 6 of the IAG (Appendix A). An estimated one and one half years will elapse from the time the Work Plan is approved by the regulatory agencies until a final report of the RFI/RI Phase I investigation is issued in July, 1994. The schedule addresses document development and regulatory review of Technical Memoranda between successive staged activities and investigation of the FSP. The schedule does not address contingencies for scheduling issues related to obtaining contractual authorization-to-proceed.

Several key elements of the Work Plan overlap chronologically. This overlap attempts to plan for flexibility which is designed into the staged investigations of the Work Plan and the critical need to implement the Work Plan on an aggressive schedule.

Data validation will begin concurrent with the site characterization task (i.e. Stages 1, 2, 3, 4 and 5). Implementing data validation concurrent with site characterization will assist in the refinement of data collection procedures and in completing the Phase I RFI/RI reporting activities within the time frame established by the IAG.

Final OU8 RFI/RI Work Plan and Field Implementation Schedule

ID	Name
1	Submit Draft Phase I Workplan
2	EPA/CDH Review of Workplan
3	Prepare Final Phase I Workplan
4	Submit Final Phase I Workplan
5	EPA/CDH Review of Final Phase 1 Work Plan
6	EPA/CDH Approval of Final Workplan
7	Prepare Project Mgmt. Plans (PMP)
8	EG&G/RFP/DOE Review & Approval (PMP)
9	Field Mobilization
10	Implement Community Relations
11	Implement Stage 1 Field Sampling Plan
12	Pepare Technical Memorandum 1 (TM1)
13	EPA/CDH Review TM1
14	Implement Stage 2 Field Sampling Plan
15	Prepare Technical Memorandum 2 (TM2)
16	EPA/CDH Review TM2
17	Implement Stage 3 Field Sampling Plan
18	Prepare Technical Memorandum 3 (TM3)
19	EPA/CDH Review TM3
20	Implement Stage 4 Field Sampling Plan

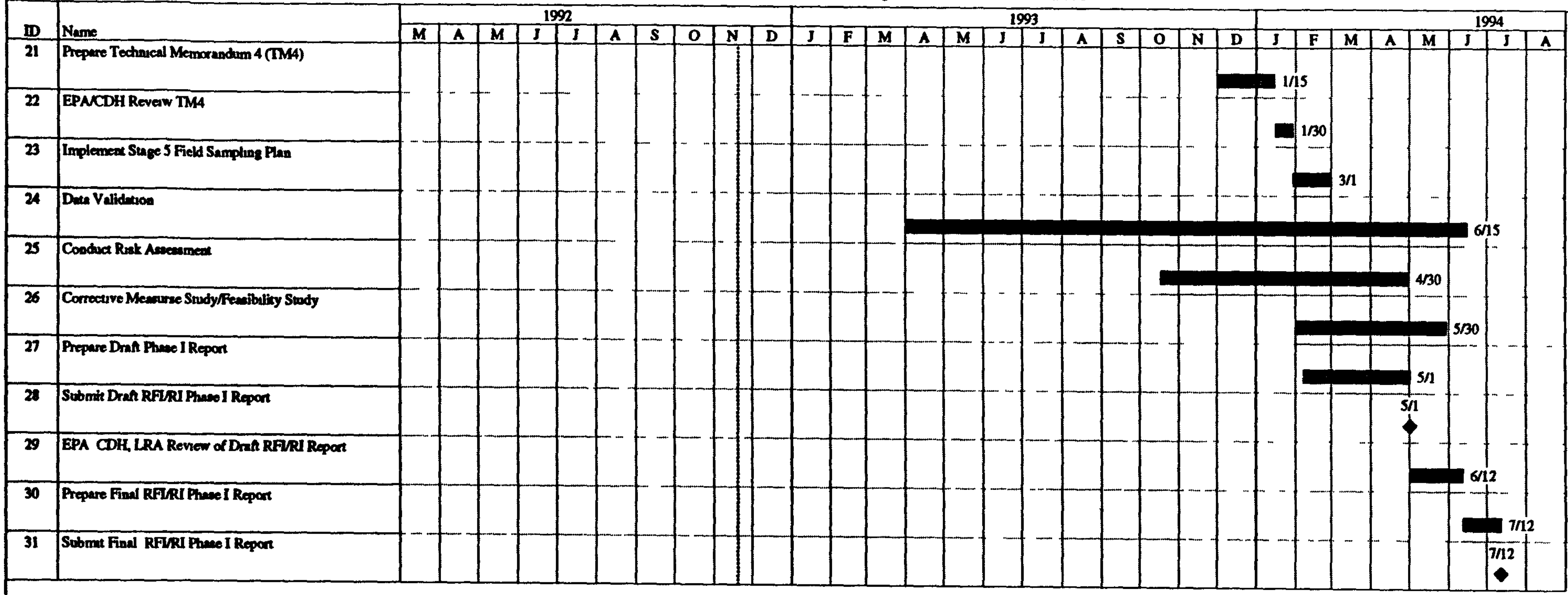


OU8 RFI/RI | Critical | Noncritical | Progress | Milestone | Summary | Rolled Up

Phase 1 RFI/RI Work Plan Operable Unit No 8 FIGURE 7-1 Final December 1 1992

2/3

Final OU8 RFI/RI Work Plan and Field Implementation Schedule



OU8 RFI/RI | Critical | Noncritical | Progress | Milestone ◆ | Summary | Rolled Up ◇

Phase 1 RFI/RI Work Plan Operable Unit No 8

FIGURE 7-1

Final December 1 1992

3/3

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Manager, Remediation Programs 6/20/94

RFI Project Manager 6/28/94

8.0 HUMAN HEALTH RISK ASSESSMENT PLAN

8.1 OVERVIEW

Following implementation of the Work Plan and validation of all acquired data, a Baseline Risk Assessment (BRA) will be conducted to evaluate potential threats to human health and the environment from constituents associated with the Rocky Flats OU8 and/or IHSSs contained within the unit boundary (Figure 8-1).

8.1.1 Regulatory Basis

Section 300 430(d) of the National Contingency Plan (i.e., Code of Federal Regulations, March 8, 1990, p 8709) states that, as part of the remedial investigation, a Human Health Risk Assessment is to be conducted as part of a BRA to determine whether contaminants of concern identified at the site pose a current or potential risk to human health and the environment in the absence of remedial action. This section describes the Human Health Risk Assessment components, which include:

- Data collection/evaluation which includes identification and description of contaminants of concern (COCs);
- Exposure assessment;

- Toxicity assessment; and

- Risk characterization.

These components correspond to the four components within the IAG required in Section VII.D.1. for contaminant identification and documentation, exposure assessment and documentation, toxicity assessment and documentation, and risk characterization. Uncertainty analysis will be an integral part of each of these four components.

Figure 8-2 illustrates the basic Human Health Risk Assessment process and components. The objective of this assessment is to identify and characterize the following:

- Toxicity and levels of hazardous and radioactive contaminants present in relevant media (e.g., air, ground water, soil, surface water, and sediment);

- Environmental fate and transport mechanisms within specific environmental media and cross-media fate and transport where appropriate;

- Potential human and environmental receptors;

- Potential exposure routes and extent of actual or expected exposure;

- Extent of expected impact or threat and the likelihood of such impact or threat occurring (i.e., risk characterization); and

- Levels of uncertainty associated with the above.

To ensure acceptance of the Human Health Risk Assessment, four technical memoranda will be prepared for review and approval by CDH and EPA. These memoranda will outline how the most crucial steps in the risk assessment will be performed and will present comprehensive and detailed information that will be included in the risk assessment. Independently derived exposure assumptions will be documented and referenced in the technical memoranda and approved by

CDH and EPA prior to completion of the HHRA The technical memoranda will address the following:

- Contaminants of concern;
- Exposure scenarios;
- Fate and transport models; and
- Toxicity values.

The Human Health Risk Assessment considers risks from both radiological and nonradiological contaminants. The EPA and DOE require a two-phase evaluation for the radiological portion of the assessment. The Human Health Risk Assessment will incorporate the two-phase analysis, which includes:

- The implementation of procedures established by the International Commission on Radiological Protection (ICRP) and adopted by the EPA used to estimate the radiation dose equivalent to humans from potential exposure to radionuclides through all pertinent exposure pathways; and

- The computation of health risk, based on the age-averaged lifetime excess cancer incidence per unit intake (and per unit external exposure) for radionuclides of concern.

Human Health Risk Assessment results will be used to determine if remedial actions are warranted at OU8 and, if so, what associated cleanup levels will be necessary to protect human health. Cleanup levels are computed during the Feasibility Study.

A number of guidance and information documents will be used to provide direction for developing the Human Health Risk Assessment. These include:

- Risk Assessment Guidance for Superfund, 1989 - Volume 1:Part A. Human Health Evaluation Manual. Interim Final. EPA/540/1-89/002 (EPA, 1989c),

- Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03 Human Health Evaluation, Supplemental Guidance: "Standard Default Exposure Factors";

- Guidance for Data Useability in Risk Assessment. Interim Final. 1990. EPA/540/G-90/008 (EPA, 1990);

- Superfund Exposure Assessment Manual. 1988. EPA/540/1-88/001 (EPA, 1988c); Procedures established by the ICRP and adopted by EPA in Federal Guidance Report No. 11 (EPA, 1988b);

- Radiation Protection of the Public and the Environment, DOE Order 5400.5;

- Risk Assessment in the Federal Government: Managing the Process. 1983. National Academy Press, Washington, D.C.; and

- Exposure Factors Handbook. EPA/600/8-89/043. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C.

- Publications of the National Council of Radiation Protection, International Council on Radiological Protection, United National Scientific Committee on the Effects of Atomic Radiation, as appropriate.

In addition to available national EPA guidance, supplemental Region VIII risk assessment guidance will be used, if applicable.

8.1.2 Background of Site Contamination

OU8 is comprised of 24 IHSSs throughout the 300, 500, 700, and 900 building areas as defined in the Final HRR (DOE, 1992b). The HRR also identifies areas of under-building contamination (UBC) and several other previously unrecognized sites that are potential areas of contamination

(PACs). Phase I RFI/RI investigations in this work Plan are confined to specific IHSSs. Although investigation of other sites are not part of OU8, the presence of those sites within the boundary of OU8 was recognized and considered and basic location information is incorporated into this plan. Historical quantitative data was addressed for those sites, however, only qualitative historical data available from the draft HRR as discussed in Section 2.2 of this work plan was considered.

Contaminants identified in the Final HRR (DOE, 1992a) at OU8 IHSSs and within the OU8 area include enriched and depleted uranium, plutonium, americium, beryllium, chlorinated solvents, chromates, hydrofluoric acid, potassium and sodium hydroxides, carbon tetrachloride, and petroleum hydrocarbons, among others. These compounds may occur in the groundwater, soils, ambient air, surface water, and sediments of OU8.

OU8 is encompassed entirely in the protected area at the RFP. Thus, the primary target population currently identified at OU8 is industrial site workers. Other target populations, including current offsite residents and future industrial and ecological site worker, will also be considered in the Human Health Risk Assessment. With DOE's future ecological land use plans for the OU8 industrial area, future onsite residents are not likely target populations. Potential exposure pathways to target populations considered may include:

- Ingestion of groundwater, surface water, sediments, and soil;
- Inhalation of airborne soil and sediment particles, vapors, and gases; and
- Dermal contact with soils, ground water, surface water, and airborne particulates.

Section 2.5 presents conceptual models of exposure pathways developed for each of three IHSS groups in OU8 using the known site physical conditions and potential contaminant sources described in Section 2.3 and 2.4. The conceptual models were developed for use in the evaluation of potential risks of OU8 contamination to human health and the environment. The IHSSs were organized into the three groups to simplify the conceptual models. The IHSSs are categorized based on contaminant source type and release mechanisms.

Data needs and DQOs presented in Section 5.2 of this work plan. Section 6.0 describes how the data needs identified will be collected. The data needs and FSP address the objectives described in Subsections 5.1 and 6.1 and include characterizing the nature and extent of contamination and the data collection necessary to assess the complete potential exposure pathways. Data to be collected in the OU8 RFI/RI or obtained from other *programs* and used in the Human Health Risk Assessment includes sampling the following media.

- **Soils:** Data characterizing vertical depth contaminant concentrations in OU8 will be used to support discussions of contaminant fate and transport and, ultimately, the exposure assessment.

- **Surficial Soils:** Radiological, nonradiological, and volatile organic compounds in surface soil data will be used to estimate potential exposure and risk through ingestion and, if necessary, estimate windborne particulate concentrations for subsequent inhalation exposures.

- **Surface Water and Sediments:** Data characterizing contaminants in surface water and sediments can be used to support discussions of contaminant fate and transport, in addition to estimating exposure and risk from ingestion or dermal contact with surface water and sediments, and inhalation of sediments.

- **Groundwater:** Data characterizing site-specific hydrogeology and potential contaminants in alluvial groundwater systems can be used to support discussions of contaminant fate and transport in addition to estimating exposure and risk from ingestion, inhalation, or dermal contact with groundwater.

- Air: Data characterizing the potential for dispersion of contaminated sediments can be used to support discussions of contaminant fate and transport in addition to estimating exposure and risk from inhalation. Air pathway analyses will be based on dispersion modeling.

A comprehensive quantitative assessment of all contaminants of concern and potential exposure pathways will be performed for surficial soils, surface water, and sediments as part of the RFI/RI. This RFI/RI includes a preliminary determination of the presence or absence of groundwater contamination at suspect OU8 IHSSs. This information may allow identification of preliminary COCs and exposure pathways for groundwater. Further investigation of groundwater contamination may result in additional RFI/RI. The preliminary schedule for implementation of this Work Plan is provided in Section 7.0. The remainder of this section generally describes the individual Human Health Risk Assessment components as they relate to the overall risk assessment.

8.2 DATA COLLECTION/EVALUATION

The objective of this section is to describe the procedures to identify contaminants potentially present at OU8 IHSSs at concentrations that could be of concern to human health. The contaminant description and identification of COCs' component of the Human Health Risk Assessment provides a summary of historical and RFI/RI data collected at OU8, provides an evaluation of historical and RFI/RI data relative to performing the Human Health Risk Assessment and describes how to use this information to perform the hazard identification. The contaminant description section includes the following information:

- Data collection;
- Data evaluation; and

- Hazard identification.

8.2.1 Data Collection

The objective of the data collection task is to summarize all data available for use in the Human Health Risk Assessment in preparation of further data evaluation activities. This step then identifies the historical data relevant to performing the Human Health Risk Assessment, assembles the RI data, and establishes data formats to facilitate data evaluation. The following data attributes are important to this step:

- Site description;
- Sample design with sample locations;
- Analytical method and detection limit;
- Results for each sample, including qualifiers; and
- Sample quantification limits and/or detection limits for nondetects;

8.2.2 Data Evaluation

Historical and RFI/RI data will be evaluated using EPA's Guidance for Data Useability in Risk Assessment (EPA, 1990). The EPA identified the following data usability criteria:

- Assessment of data documentation for completeness;
- Assessment of data sources for appropriateness and completeness;
- Assessment of analytical methods and detection limits for appropriateness;

- Assessment of sampling data quality indicators (completeness, comparability, representativeness, precision, and accuracy); and
- Assessment of analytical data quality indicators (such as spike recoveries, duplicates, and blanks) for completeness, comparability, representativeness, precision, and accuracy.

The RFI/RI data that can be used to support a quantitative Human Health Risk Assessment will be identified. Part of this evaluation will include identification of the most appropriate summary process and format. This will involve identifying statistical summary techniques that consider spatial and temporal data distributions, determining if arithmetic or geometric means are appropriate, and determining the appropriate method for dealing with nondetected values and qualified data. The data summary will include:

- The frequency of detection (number of positive detects/number of analyses) for each compound and sample location; and
- The minimum- and maximum-reported concentrations for each contaminant at each sample location.

Tentatively identified compounds (TICs) reported in the RFI/RI will be evaluated relative to their usefulness in the Human Health Risk Assessment. It is anticipated that risks resulting from exposure to TICs will not be characterized because of the absence of specific contaminant identity and available toxicological information.

8.2.3 Hazard Identification

The objective of the hazard identification is to identify RFP-related contaminants present at OU8 in concentrations high enough that may be of concern relative to human health considerations. The HRR identified uranium, plutonium, beryllium, chlorinated solvents, chromates, acids, and hydraulic oil within OU8. In addition to these contaminants, others may be identified based on RFI/RI analytical results. Criteria for performing the hazard identification include, but may not be limited to:

- Frequency of detection;
- Environmental media concentrations which exceed background concentrations; and
- Comparison with Health/Environmental criteria.

8.2.4 Selection of Contaminants of Concern

Analytical results from OU8 field sampling will be screened to retain those contaminants which are most likely to contribute significantly to risks the public. These COCs represent the most toxic, persistent, or mobile contaminants identified at an OU. If COCs are selected, adequate documentation will be prepared to justify including or excluding specific contaminants. As required by the IAG Section VII.D.1.a, a technical memorandum which includes a listing of the hazardous substances present and the criteria for their selection will be prepared and submitted to the EPA and State of Colorado for review and approval. The COCs selected from this list will be included in the memorandum with the known corresponding ambient concentrations of these contaminants. The memorandum will be submitted prior to the required submittal of the HHR for OU8.

A flowchart to be used in screening COCs has been developed from the discussion in the Risk Assessment Guidance for Superfund (RAGS) Sections 5.8, 5.9, and 10.4 (EPA, 1989c) by the Rocky Flats Plant Risk Assessment Technical Working Group and is shown on Figure 8-3. In general, each box contains a screening criteria which may be answered "yes" or "no". Flow to the left indicates contaminants that will be deleted from quantitative risk assessment unless associated with an anomalous area, defined as 10 times the mean site concentration. Contaminants that the screening process moves to the right of the flowchart will be retained for quantitative risk assessment unless they are identified as essential human nutrients. Analytical results from the OU8 field sampling program will be screened in order to retain those contaminants which are most likely to contribute significantly to human health risks.

The screening process begins with analytical results from the site-specific chemical analysis list set forth in this work plan. The data will be evaluated according to RAGS section 5.9.3 to determine if the detection frequency is greater than 5 percent. The chemical will be considered for elimination from the quantitative risk assessment if:

- It is detected in one or perhaps two environmental media;
- It is not detected in any other sample media, or at high concentrations; and
- There is no reason to believe that the chemical may be present (EPA, 1989b).

Contaminants with a detection frequency less than or equal to 5 percent will be screened to determine if they were detected in anomalous areas not previously known and/or outside of the current IHSS boundary(s). Contaminants with low detection frequency that were not detected in anomalous areas will be deleted from further consideration. Contaminants with a detection frequency greater than 5 percent will be retained for further screening.

As discussed in RAGS sections 5.8(3) and 10.4.7, remaining contaminants will be screened to determine if the concentration is statistically different from background. This second step in the screening process employs appropriate parametric and non-parametric statistical data evaluation methods (e.g., tolerance intervals, analysis of variance [ANOVA], etc.). Guidance on statistical methods includes RAGS (EPA, 1989c), Guidance for Data Useability in Risk Assessment (EPA, 1990), Methods for the Evaluation of Cleanup Standards (EPA, 1989b), and Statistical Methods for Environmental Pollution Monitoring (Gilbert, 1987). Those contaminants which are not detected at concentrations statistically elevated above background will be considered for elimination, but will be further screened to determine if they are associated with anomalous areas. If they are not statistically elevated above background or associated with anomalous areas, they will be eliminated.

The next step in the screening process is to determine if the chemical is considered a carcinogen. As indicated in Figure 8-3, EPA guidance will be employed to identify chemicals that are classified as Group A, B, or C carcinogens. This screening step does not eliminate a chemical from further consideration unless it is statistically below background levels. Otherwise, the process automatically identifies carcinogens for inclusion in the risk assessment, even if detected at low concentrations.

Non-carcinogens retained for further screening will be checked to determine if mean concentrations are greater than one-tenth the value of identified health protective criteria (e.g., reference dose-based criteria, drinking water standards, etc.). Contaminants with mean concentrations greater than one-tenth health/environmental criteria will be retained in the screening process. If the mean concentration is less than one-tenth health protective criteria, the contaminant is reviewed for mobility, persistence, or significant decay products. Mobility may be evaluated according to criteria such as high volatility, high solubility, and low organic carbon partition coefficient (K_{oc}) and persistence may be evaluated according to criteria such as half-life and bioaccumulation. For example, as K_{oc} increases, a contaminant is more likely to remain in water than to bind to sediment or soil. Contaminants that are not highly mobile, persistent or possess significant decay products and are not associated with hot spots will be eliminated. Contaminants determined to be highly mobile or persistent may be retained for further screening.

The final screening step is to determine if any of the contaminants retained in the screening process are essential human nutrients. As stated in RAGS section 5.9.4, "chemicals that are essential human nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses (i.e., much higher than those associated with contact at the site) need not be considered further in the quantitative risk assessment. Examples of such chemicals are iron, magnesium, calcium, potassium, and sodium" (EPA, 1989c). Consequently, contaminants that meet the essential nutrient criteria will not be considered further.

Contaminants retained through the screening process represent the most prevalent, toxic, persistent or mobile contaminants. These will be added to the list of contaminants of concern, which will be used in the quantitative risk assessment.

There are inherent uncertainties that must be recognized in the data collection and evaluation component of the Human Health Risk Assessment. Uncertainties include those associated with field sampling laboratory analysis and laboratory quality assurance procedures, and with accuracy of the RFEDS database or other databases compiled for use in the risk assessment. All of these sources of information are used to identify and describe COCs.

8.3 EXPOSURE ASSESSMENT

The objectives of the exposure assessment are to identify actual or potential chemical and radiological exposure pathways, characterize potentially exposed populations, and determine the concentration and duration of exposure. The exposure assessment includes several tasks:

- Characterization of the exposure setting relative to contaminant fate and transport and potentially exposed populations;

- Identification of exposure pathways which are comprised of a source and mechanism of release to the environment, an environmental transport medium, a point of potential contact for humans or biota, an exposure point, and an exposure route at the exposure point;

- Identification of exposure scenarios associated with pathways to current and potential future exposed populations; and

- Identification of uncertainties associated with the exposure assessment that impact the risk characterization.

Exposure is defined as the contact of an organism with a contaminant or physical agent. The magnitude of exposure is determined by measuring or estimating the amount of a contaminant available at the exchange boundaries. When contaminants migrate from the site to an exposure point, or when a receptor directly contacts contaminated media, exposure can occur.

8.3.1 Conceptual Site Model

The conceptual site model developed for OU8 discussed in Section 2.5 will be used to evaluate primary and secondary contaminant sources and releases, and potential receptors and associated exposures. The models help to characterize the exposure setting relative to contaminant fate and transport mechanisms through exposed receptors. These models may be revised, based on RFI/RI data collected for the OU, to incorporate new information.

To assess the potential adverse health effects associated with access to the site, the potential level of potential receptor exposure to the selected contaminants must be determined. Both current and potential future receptors are considered in this determination. The primary current receptors identified at OU8 include occupational site workers, offsite residents, livestock, and aquatic and terrestrial wildlife. Offsite potential future receptors include light industrial and ecological site workers. Future onsite residential receptors will be considered, although it is highly unlikely the RFP will allow unrestricted, residential use in the future.

Intakes of potentially exposed receptors will be calculated separately for all appropriate pathways of exposure to contaminants. Then, the total chronic intake by each route of exposure will be calculated by adding the intakes from each pathway. Total oral, inhalation, and dermal chronic exposures as well as external exposure from radionuclides will be estimated separately. Exposure concentrations will be estimated as described in Section 8.3.4 for a variety of reasonable exposure conditions in order to evaluate the range of plausible exposure concentrations. At a minimum, the exposure assessment will consider the estimated minimum, expected, and reasonable maximum exposure (RME) concentrations. RME concentrations are represented by the 95th percent confidence limit on average concentration.

8.3.2 Contaminant Fate and Transport

The conceptual site model helps identify potential contaminant fate and transport mechanisms. These could include soil contents leaching to groundwater and subsequent transport, soil entrainment and downwind deposition, or surface runoff that transports surface soil and sediments downslope. Contaminant-specific characteristics affect fate and transport. Compound-specific factors affecting the probability a contaminant will migrate include, but are not limited to, the following:

- Solubility;
- Partition coefficients;
- Vapor pressure;
- Henry's Law constant;

- Bioconcentration or dilution factors; and
- Half-life or degradation in the environment.

The evaluation of these factors will help determine if contaminants can migrate from their sources to potential receptors. This includes not only those receptors identified under current use scenarios, but those identified under potential future exposure scenarios as well.

Models utilized for fate and transport evaluation will be described and submitted in a technical memorandum to the EPA and State of Colorado for review and approval as required by the IAG Section VII.D.1.b. The memorandum will include a summary of the data that will be utilized in these models. Representative data will be utilized and the stations, assumptions, and uncertainties associated with the models shall be documented. This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

8.3.3 Exposure Pathways

By using the conceptual site model and information on contaminant fate and transport, exposure pathways can be identified. This information, combined with data on the physical site setting and potentially exposed site workers, will be used to identify and evaluate complete exposure pathways. The Human Health Risk Assessment will consider only complete exposure pathways, those for which data support the presence of a source, release mechanism, transport mechanism, exposure route, and affected receptor. Complete exposure pathways include the receptors and exposure route (ingestion, inhalation, dermal, and external irradiation).

As required by the IAG Section VII.D.1.b, a technical memorandum will be submitted to EPA and the State of Colorado for review and approval concerning the exposure scenarios. The memorandum will describe the present, future, potential, and reasonable-use scenarios. A description of the assumptions made and the data used will be included. This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

8.3.4 Exposure Point Concentrations

By using the data set identified as part of Subsection 8.2.2, exposure point concentrations will be estimated. Some data will be collected at the point of exposure. Other data collected at the source may be used in conjunction with a transport model to estimate expected concentration at some exposure point. Because modeling may add uncertainty, the work plan emphasizes collecting data at exposure points where possible, even though these data provide only a snapshot of conditions in time and space.

A statistical approach will be taken to characterize a range of exposure point concentrations for representative exposure scenarios and conditions. The initial step will be to evaluate and characterize the underlying statistical distribution (e.g., normal, lognormal, etc.) through classical methods such as histograms and goodness of fit tests, and similar summary statistics. Based on this initial assessment, suitable measures of central tendency and dispersion such as the mean, variance, and similar summary statistics will be developed. These measures will be used to characterize exposure point concentrations for different cases of interest such as: the expected case; the 95 percent lower confidence limit case, and the 95 percent upper confidence limit the RME case.

8.3.5 Contaminant Intake Estimation

Contaminant intake or exposure is normalized for time and body weight and is expressed as milligrams of chemical per kilogram of body weight per day (mg/kg/day). Radionuclide intake is expressed in picocuries (pCi). Six basic factors are used to estimate intake: exposure frequency, exposure duration, contact rate, chemical concentrations, body weight, and averaging time. These factors are based on the types of exposure (e.g., ingestion, inhalation, or dermal).

The lower confidence limit, upper confidence limit, and average exposure point concentrations are used in conjunction with receptor activity patterns to estimate contaminant intake for each exposure route as appropriate. EPA guidance such as Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors Interim Final, March 25, 1991 (EPA, 1989c) will be consulted in developing bounding case exposure parameters to support an unbiased exposure assessment. Also, the averaging time for carcinogens and noncarcinogens differ.

Other standard contaminant intake rates established by the EPA that will be used, if appropriate, include the following:

- Soil ingestion rates based on age; and
- Inhalation rates based on activity levels.

Contaminant intake rates can also be estimated for dermal exposures. Of the four routes of exposure (ingestion, inhalation, dermal, and external irradiation), the greatest uncertainty is associated with dermal exposures.

8.3.6 Uncertainly in the Exposure Assessment

The ability to construct exposure scenarios for a site depends on the amounts and kinds of environmental data collected for that purpose. Some uncertainty is inherent in environmental data collection. The numbers and kinds of uncertainties included in the exposure assessment directly impact the risk characterization; many professional judgements impact the identification and description of physical site attributes that affect exposure and activity patterns. One of the major areas of uncertainty in the exposure assessment is the prediction of human activities that lead to contact with environmental media and exposures to site-related contaminants. This section of the Human Health Risk Assessment will identify and evaluate how site attributes related to environmental sampling and analysis, fate and transport modeling, and exposure parameter estimation and assumptions about them affect assessing risk. Uncertainty analysis will be performed to characterize and quantify, if possible, the sources and magnitudes of uncertainty in the data collection and evaluation component. Quantitative techniques may include sensitivity analysis, or numerical methods such as Monte Carlo analysis. A more detailed description of uncertain analyses considered for use in completing the overall Human Health Risk Assessment for OU8 is in Section 8.5.

8.4 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to describe the contaminants considered in the Human Health Risk Assessment relative to their potential to cause harm. The toxicity assessment has two general steps. The first determines what adverse health impacts, if any, could result from exposure to a particular contaminant. These are typically classified as carcinogenic and noncarcinogenic health effects. The second step, the dose-response evaluation, quantitatively examines the relationship between the level of exposure and the incidence of adverse health effects.

Toxicity depends on the dose or concentration of the substance (dose-response relationship). Toxicity values are a quantitative expression of the dose-response relationship for a contaminant and take the form of Risk Reference Dose (RfD) and cancer slope factors, both of which are specific to exposure via different routes.

Two sources of toxicity values are currently available for chemicals and radionuclides. The primary source is the EPA's Integrated Risk Information System (IRIS) database, which contains up-to-date health risk and regulatory information. IRIS contains only those RfDs and slope factors that have been verified by EPA work groups, and is considered by EPA to be the preferred source of toxicity information for chemicals.

Following IRIS, the most recently available Health Effects Assessment Summary Tables (HEAST), issued by EPA's Office of Research and Development, will be consulted to identify interim RfDs and slope factors for chemicals and radionuclides. Other sources such as ICRP and National Commission on Radiological Protection (NCRP) will also be consulted.

Toxicity values for substances identified in OU8 which lack EPA toxicity values can be developed in consultation with EPA's Environmental Criteria Assessment Office (ECAO). It is not expected that toxicity values will be developed within the OU8 Human Health Risk Assessment.

A technical memorandum listing the toxicological and epidemiological studies utilized to perform the toxicity assessment as required by the IAG Section VII.D.1.c. will be submitted to EPA and the State of Colorado for their review and approval This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

In addition to identifying appropriate toxicity values, this section of the Human Health Risk Assessment will provide brief toxicity profiles based on recent, published literature for each contaminant evaluated in the Human Health Risk Assessment. These profiles will describe the acute, chronic, and carcinogenic health effects associated with radioactive and nonradioactive contaminants identified in OU8. Acute and chronic exposure to site related radionuclides will be discussed, but most of the information presented will deal with the carcinogenic hazard posed by the site-specific radionuclides.

The toxicity assessment section will include an evaluation and discussion of uncertainties. The numbers and kinds of uncertainties identified for the toxicity assessment directly impact the risk assessment. Uncertainties for the toxicity assessment are associated with the toxicity values and their derivation, or the lack of toxicity values for site-related contaminants. Uncertainties include, but may not be limited to, the following:

- Not all constituents at the site have critical toxicity values (such as cancer slope factors or reference doses). Therefore, potential risk cannot be quantified for these constituents and this may underestimate risk from the site.

- Using cancer slope factors derived from the upper 95th percent confidence limit is likely to lead to overestimation of risk. Carcinogen slope factors assume no threshold for effects; if thresholds do exist, the true risks could be zero at sufficiently low doses.

- Lacking toxicity data, synergistic or antagonistic effects cannot be accounted for quantitatively.

Critical toxicity values derivation include, but may not be limited to, the following:

- Extrapolating toxicity values from high experimental doses to low doses for environmental exposures;
- Extrapolating data from tests with experimental animals to humans; extrapolating test data collected over short durations to long-term exposure durations;
- Extrapolating data collected using homogeneous experimental animal populations to humans who individually can vary substantially in their dose-response reactions;
- Extrapolating from continuous experimental doses given to animals to intermittent human exposures; and
- Extrapolating absorption rates.

The methods used to derive slope factors and reference doses are intended to be conservative in recognizing these types of uncertainties. In addition to the numerical approaches used to incorporate uncertainty in deriving toxicity values, the overall quality of the toxicology data base for a compound is evaluated. This can include consideration of a number of studies, their consistency, the availability of information on multiple species and multiple routes of administration, the demonstration of a clear dose-response relationship, plausible biological mechanisms of action, and especially direct evidence of effects in humans. Such reviews are performed by the EPA in developing toxicity parameter values and result in an overall evaluation of the confidence level in the toxicity values. Not all toxicity values represent the same degree of uncertainty; all are subject to change as new evidence becomes available.

8.5 RISK CHARACTERIZATION

This part of the Human Health Risk Assessment presents the evaluation of potential risks to public health associated with exposure to contaminants at the OU8 site. Potential carcinogenic and noncarcinogenic risks associated with complete exposure pathways will be estimated. Risk characterization involves integrating exposure assumptions and toxicity information to quantitatively estimate the risk of adverse health effects. Risk characterization will be performed in accordance with EPA guidance (EPA, 1989c).

Noncancerous health effects will be assessed by comparing the estimated daily intake or exposure to a contaminant to its RfD. This comparison measures the potential for noncarcinogenic health effects given the chemical intake factors used to estimate exposure. To assess the potential for noncancerous effects posed by multiple contaminants, the EPA's hazard index approach will be used. The method assumes dose additivity. Hazard quotients (individual chemical intake divided by the chemical RfD) are summed based on identification of target-tissues and like impacts to provide a hazard index; if the index exceeds one, there is a potential for health effects.

The potential for carcinogenic effects for nonradiological contaminants will be estimated by calculating excess lifetime cancer risks from the lifetime average exposure and cancer slope factor. IRIS slope factors for radionuclides of concern will be used to estimate risks from exposure for up to four pathways: inhalation, ingestion, air immersion, and external irradiation. HEAST tables will also be used to identify interim RfDs and slope factors for any radionuclides of concern not included in the IRIS database, and radiological risks will be estimated according to guidance provided by the EPA (1989c). As a latter step in estimating risks, coordination will be conducted with the EPA, Region VIII, Environmental Criteria Assessment Office (ECAO) for assistance in developing toxicity values.

For radiological contaminants, dose to the public will first be determined for the pathways in question for each radionuclide of concern. Based upon these doses, the risk of an effect will be determined using age- and sex-specific coefficients for individual organs receiving radiation doses. In accordance with EPA guidance, organ-specific dose conversion factors will be used to derive slope factors that represent the age-averaged lifetime excess cancer incidence per unit intake for the radionuclides of concern. The sum of the risks from all radionuclides and pathways yields the lifetime risk from the overall exposure. Risks will be combined as appropriate, taking into consideration the plausibility of multiple exposures.

The Human Health Risk Assessment will present the chemical and radiological risk estimates separately with discussion on the additivity potential for these risks. Both noncancerous and cancer risks will be estimated by using RME combined with exposure assumptions. This allows risk ranges to be considered rather than as a single value, and more closely considers the uncertainty associated with the estimates. Radiological risk will be presented in terms of the three common formats currently used in the radiologic and regulatory communities. These include: HEAST-type calculations as described in EPA's Risk Assessment Guidance for Superfund, Committed Effective Dose Equivalent (50 year commitment) also which is also suggested by EPA, and the more conventional accrued effective dose equivalent method used in the practice of health physics. In addition, risks may be added across exposure routes if conditions for doing so (i.e., biologically plausible and consistent with reasonably expected exposure scenarios) indicate that it is appropriate.

Not all contaminants identified at OU8 will have toxicity values, thereby limiting the ability to develop quantitative estimates of risk. Where adequate toxicity values cannot be identified, potential risks associated with exposure to those constituents will be dealt with qualitatively.

The numbers and kinds of uncertainties identified in the Human Health Risk Assessment directly impact the interpretation of estimated risks developed in this section. Quantitative risk estimates derived in risk assessments are conditional estimates that include numerous assumptions about exposures and toxicity. Uncertainty is introduced from a variety of sources including, but not limited to, the following:

- Sampling and analysis;
- Exposure estimation;
- Exposure population dynamics; and
- Toxicological data.

Risk assessment involves extrapolation of often incomplete data and information obtained under one set of conditions to a likelihood or probability of events to be encountered under different circumstances. The objective of this task will be to evaluate the reliability of the Human Health Baseline Risk Assessment as a scientifically credible instrument upon which to base risk management decisions. An uncertainty analysis will be performed to characterize and quantify, to the extent practicable, the sources and magnitudes of uncertainty in the Human Health Risk Assessment.

The existing data bases may be inadequate for accurate analysis, and the complexity of the process requires the incorporation of expert or subjective judgments. Quantitative techniques may include sensitivity analysis of testable or untestable assumptions, first-order analysis to evaluate the propagation of errors, or numerical methods such as Monte Carlo analysis. To handle uncertainty, other methods of analysis of incomplete data sets may utilize Batesian theorems, expert systems that analyze the consequences of events relative to others, or other types of logic systems such as event or fault trees. The results of these analyses can be converted into quantitative terms to express probabilities.

27/28

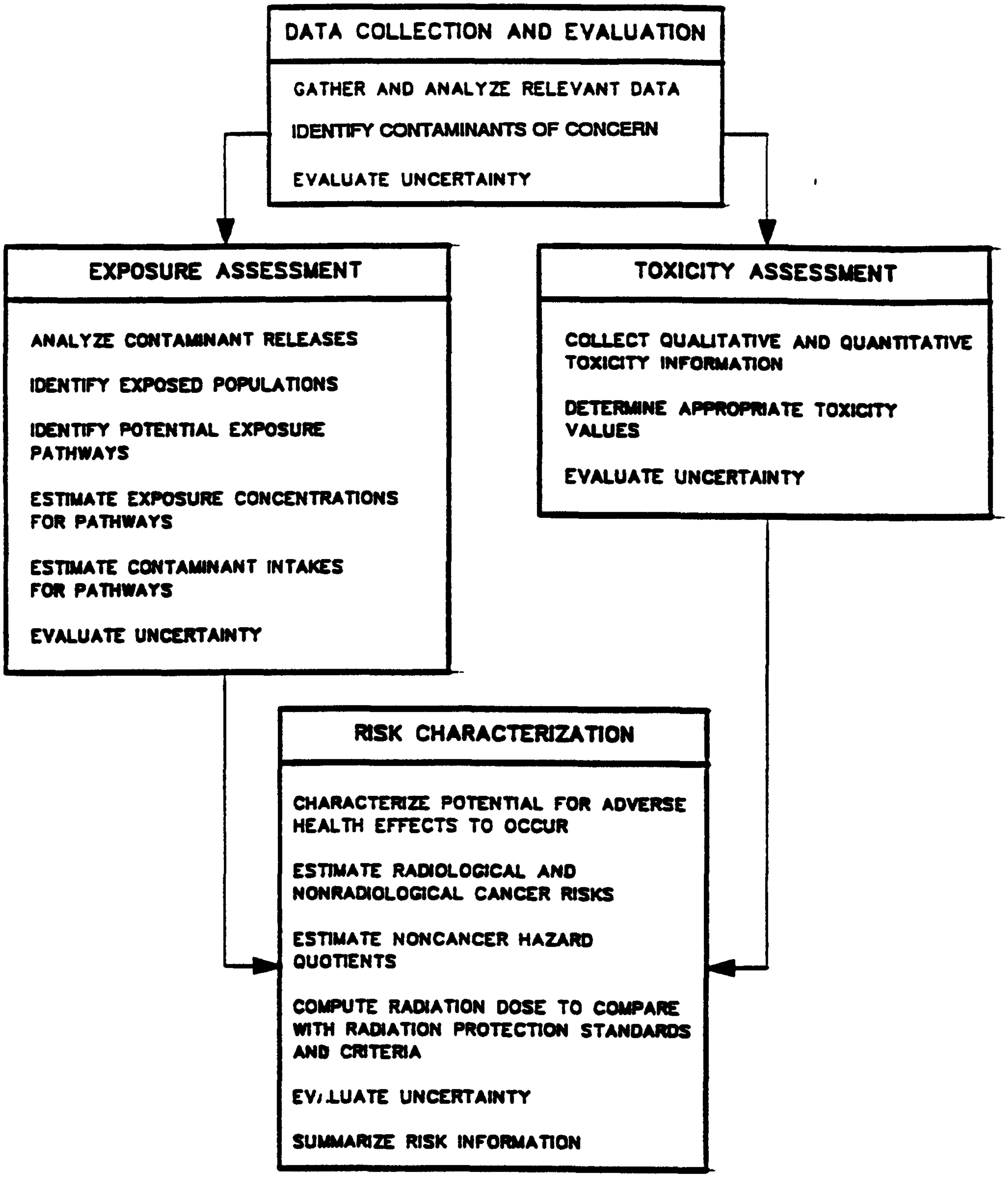

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FIGURE 8-2
HUMAN HEALTH RISK ASSESSMENT

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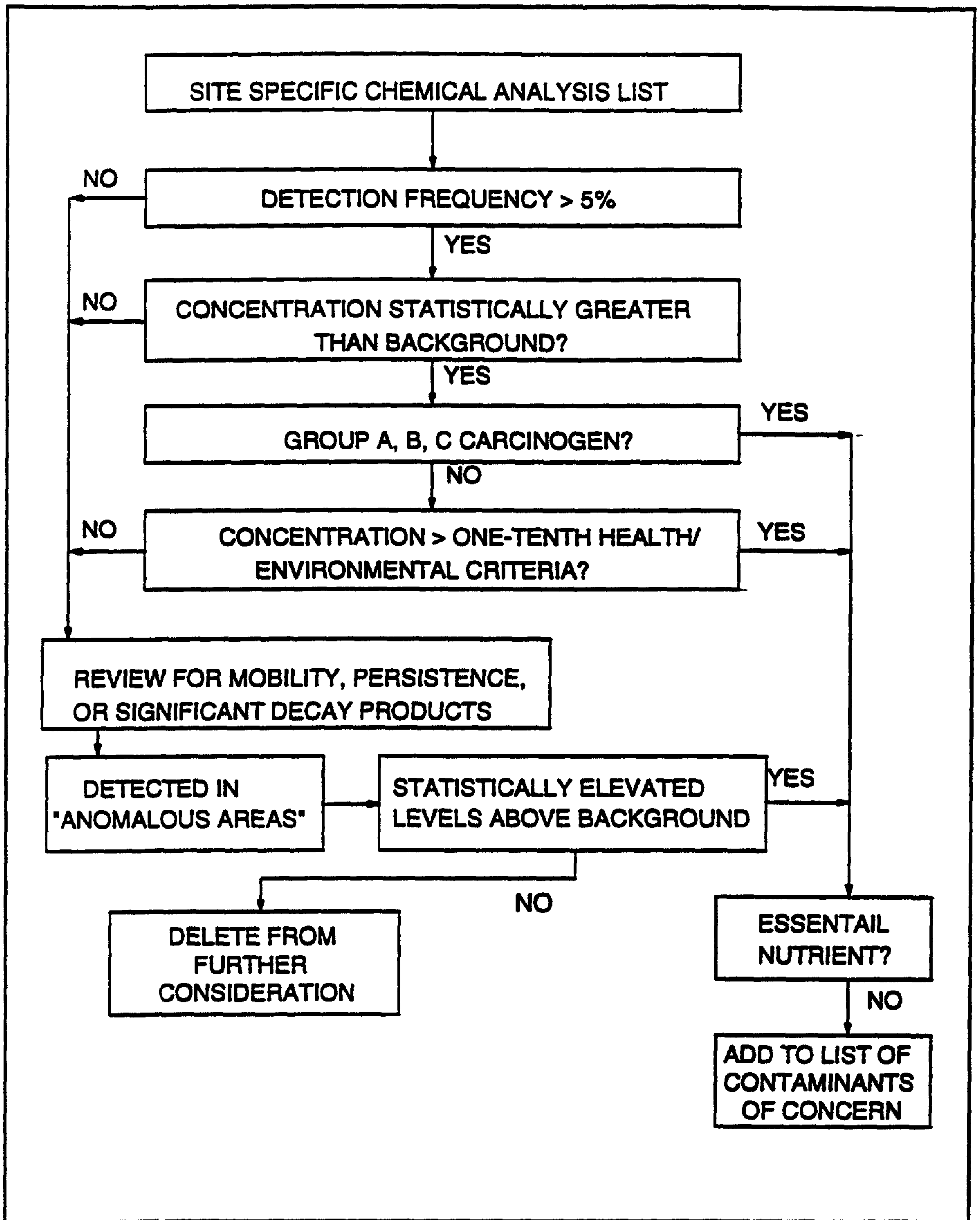

FIGURE 8-3

PROTOCOL FOR IDENTIFICATION OF CONTAMINANTS OF CONCERN FLOW CHART

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Approved By

Manager, Remediation Programs 6/28/94 RFI Project Manager 6/28/94

9.0 ENVIRONMENTAL EVALUATION WORK PLAN

9.1 INTRODUCTION

OU8 lies entirely within the production area at RFP in areas surrounding the building complexes 300, 700, and 900 This area has been developed to such an extent that there are no viable ecosystems or natural habitats There are insufficient ecosystems, components, or functions existing within OU8 to require or allow a comprehensive ecological risk assessment. OU8 overlaps with several other plant site OUs and is largely included within the OU9 ecological study area, which extends throughout most of the RFP production area The OU9 Environmental Evaluation Work Plan (EEWP) (EG&G, 1992g) provides for an ecological risk evaluation of the production area focused on requirements appropriate for the depauperate ecosystems that exist there The objective of the OU8 EE is to address and characterize any potential for adverse impacts to ecosystems or ecological resources present or at other locations and then to determine if there is a risk of contamination via abiotic or biotic transport.

Coordination of OU8 EE requirements with the OU9 EE is required due to the overlapping study areas Habitat and biological surveys proposed for OU9 will cover the entire industrial area, and as a result will apply to OU8 Following is a brief description of the study components proposed for OU9 and how these studies relate to the OU8 EE This description is based on the final EE technical memorandum for OU9 dated June 1992 that has been submitted for agency review. Due to the extensive overlap of OU9 and OU8, it is expected that all work related to the EE for OU8 will be conducted as part of the OU9 Work Plan. However, should the OU8 Work Plan be implemented prior to OU9, the EE described in OU9 will then be implemented as part of the OU8 activities

9.2 BIOLOGICAL AND HABITAT SITE CHARACTERIZATION

Biota and habitat surveys proposed for OU9 will be adequate for the biological and habitat characterization of OU8 and will not be duplicated or repeated. The target list of taxa including migratory birds, and other species of concern will be in accordance with the same listing to be presented in the EEWP and technical memoranda for OU9 (see Section 9.3) These surveys will provide the following information applicable to OU8.

- Comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support migratory birds;
- Presence and/or use of habitats by raptors and migratory birds, including waterfowl and passerine species;
- Presence or absence of threatened and endangered species, or species of special concern, and
- Data on small and large mammal or bird population dynamics, if present.

This characterization will include a literature review, expert consultation, and field surveys for 1) vegetation, 2) species of special concern, 3) small and large mammals, and 4) birds. Soil series will not be mapped because of the heavily disturbed nature of the soil surface within OU8. This information will be included in the following three reports:

- Habitat survey report for compliance with acts for protection of migratory birds;
- Biological survey report for compliance with acts and regulations protecting threatened and endangered species; and
- Reporting of results of small and large mammals and bird surveys.

9.3 ECOTOXICOLOGICAL INVESTIGATIONS

Details of the Ecotoxicological Investigation approach and its schedule to initiate and complete it within an entire EE for a one-phase RFI/RI are described in the final technical memoranda for OU9 (EG&G, 1992g). The ecotoxicological work will be completed after surficial soils, sediments, and surface water samples are collected and the analytical data evaluated. Ecotoxicological investigations will be conducted if the following conditions are present on OU8.

- If target taxa are present on the study area and could accumulate or concentrate target analytes; and either
- The contaminated target taxa are capable of migration outside the OU8 study boundaries, or
- The contaminated target taxa are highly mobile and actually move outside the study or industrial area boundaries.

If the above conditions are not met, then it is presumed that there is no risk of contamination of off-site biota from OU8

If an ecotoxicological investigation is necessary, it would consist of the following procedures:

- Developing a site-specific Conceptual Exposure Model to identify potential pathways for exposure of on-site biota;
- Developing a Conceptual Biota Transport model to identify potential pathways for off-site transport;
- Selection of target taxa and target analytes (biologically active COCs); and
- Direct measurement of target analytes within target taxa.

A Technical Memorandum will be prepared and submitted for EPA and CDH review and approval and U.S Fish and Wildlife Surface and Colorado Department of Wildlife review prior to initiating any work.

The procedures for conducting this type of investigation for the industrial area are presently under development for OU9 and would be adapted, if needed, for the highly disturbed study area in OU8

This information would be used to assess the ecological risk posed by contaminant migration by biological pathways Information on contaminant migration by target taxa to other Ous will be provided to those OU managers for use in conducting their EEs for identifying ecological risks This would be a quantitative estimate with the appropriate uncertainty analysis for model assumptions and estimates of parameters This information would also be coordinated with contaminant migration by physical or abiotic media developed during the site characterization and transport models

9 4 ENVIRONMENTAL EVALUATION REPORT

The EE portion of the BRA in the Phase I RFI/RI report will consist of the habitat survey, biological survey and small mammal and bird survey reports discussed in Section 9.2 If an ecotoxicological investigation is conducted in Phase I, the results could be included in the EE portion of the BRA in the Phase I RFI/RI report.

Approved by:

Manager, Remediation Programs 6/28/94

RFI Project Manager 6/28/94

10.0 QUALITY ASSURANCE ADDENDUM

All work conducted in support of OU8 Phase I RFI/RI activities will be directed by the EG&G Environmental Management Department Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facilities Investigation/Corrective Measures Study Activities (QAPjP). The QAPjP complies with the requirements of EPA QAMS-005/80 and DOE Order 5700.6B which addresses NQA-1.

The QAPjP will be supplemented by a Quality Assurance Addendum (QAA) specific to OU8 and provided to ASI by EG&G for inclusion in the Work Plan after EG&G completes its review of a draft iteration of this Work Plan. The QAA will establish the specific Quality Assurance (QA) controls applicable to the field investigation activities described in the Plan.

The QAA provided by EG&G that will guide the activities presented in this Work Plan are presented on the following pages in this section.

10.1 INTRODUCTION

This section consists of the QAA for Phase I investigations at Operable Unit No. 8 (OU8), which supplements the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP). This QAA establishes the site-specific QA controls applicable to the investigation activities described in the OU8 Work Plan (OU8 WP).

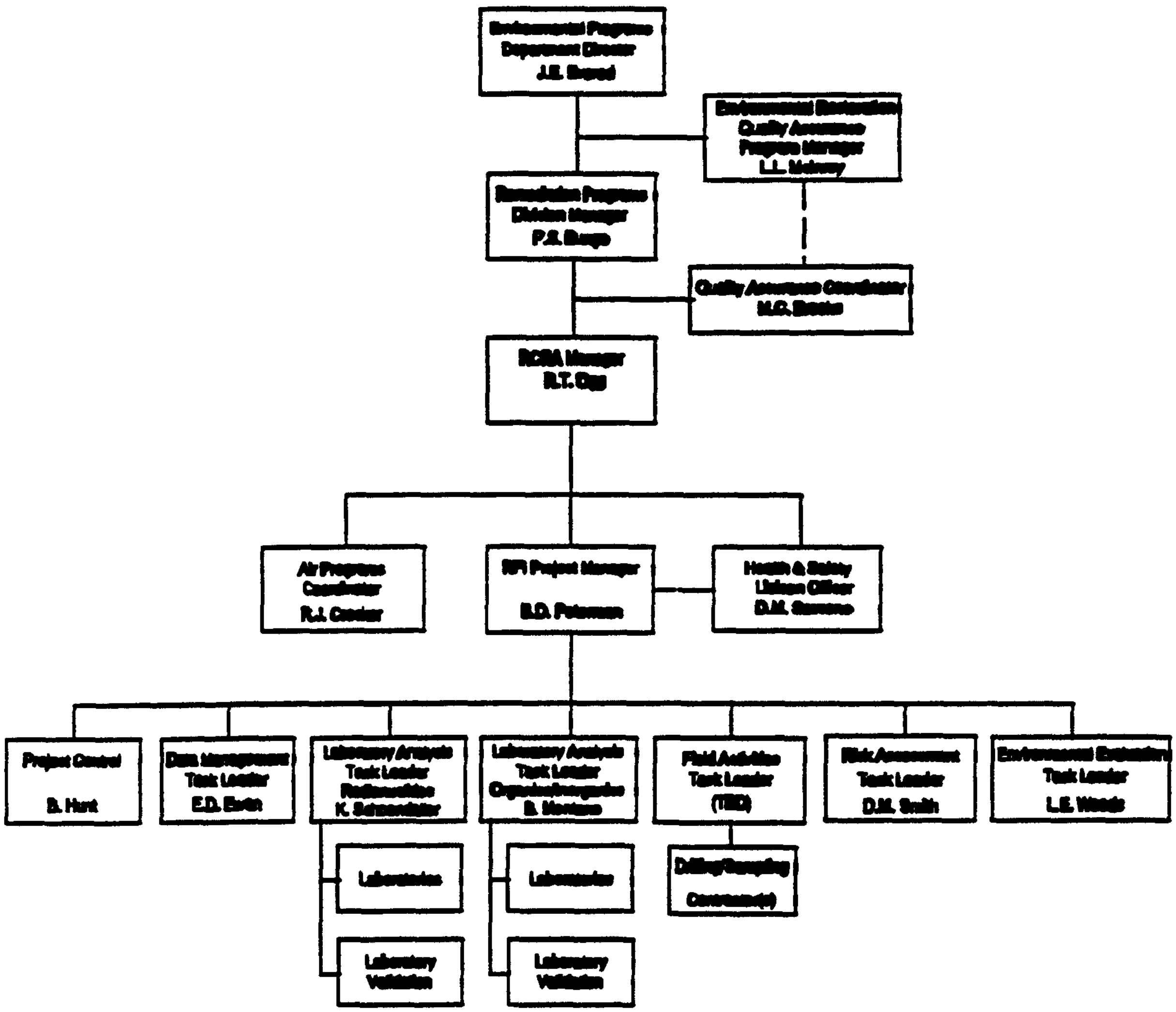
OU8 is one of 16 operable units identified for investigations under the Rocky Flats Plant Interagency Agreement. OU8 contains 24 IHSSs which are described in Section 2.3 of the OU8 WP. Section 2.4 describes the nature and extent of contamination at the IHSSs within OU8. The OU8 WP was prepared in accordance with EPA/530/SW-89-031, RFI Guidance (EPA 1989a), EPA/540/8-89/004, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988a), and the IAG.

10.1.1 Organization and Responsibilities

The overall organization of EG&G Rocky Flats and the EMD and divisions involved in ER Program activities is shown in Figures 1-1, 1-2, and 1-3 of Section 1.0 of the QAPjP. Individual responsibilities are also described in Section 1.0 of the QAPjP.

Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OU8 WP. The specific EMD personnel who will interface with the Contractors and who will provide technical direction are shown in Figure 10-1.

FIGURE 10-1. PROJECT MANAGEMENT FOR OPERABLE UNIT 8 700 AREA, PHASE I RFI/RI



10.1.2 Quality Assurance Program

The QAPjP was written to address QA controls and requirements for implementing IAG-related activities. The content of the QAPjP was driven by DOE RFP SOP 5700.6B, which requires a QA program to be implemented for all RFP activities based on American Society of Mechanical Engineers (ASME) NQA-1, "Quality Assurance Requirements for Nuclear Facilities," as wall as the IAG, which specifies that a QAPjP for IAG-related activities be developed in accordance with EPA/QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans." The 18-element format of NQA-1 was selected as the basis for both the QAPjP and subsequent QAAs with the applicable elements of QAMS-005/80 incorporated where appropriate. Figure 2-1 of the QAPjP illustrates where the 16 QA elements of QAMS-005/80 are integrated into the QAPjP and also into this QAA. Section 2.0 of the QAPjP also identifies other DOE Orders and QA requirements documents to which the QAPjP and this QAA are responsive.

The controls and requirements addressed in the QAPjP are applicable to OU8 Phase I activities, unless specified otherwise in this QAA. Where site-wide actions are applicable to OU8 activities, the applicable section of the QAPjP is referenced in this QAA. This QAA addresses additional and site-specific QA controls and requirements that are applicable to OU8 Phase I activities that may not have been addressed on a site-wide basis in the QAPjP. Many of the QA requirements specific to OU8 are addressed within other section of the OU8 WP and are referenced in this QAA.

10.1.2.1 Training

Personnel qualification and training requirements for RFP ER Program activities are addressed in Section 2.0 of the QAPjP. Personnel qualifications and training required to perform the EMD Operating Procedures (OPS) and Environmental Management Radiological Guidelines (EMRGs) that are applicable to OU8 investigations are specified within the respective procedures. The EMD OPS (which may also be referred to as EM SOPs in the QAPjP and the OU8 WP) and EMRGs that are applicable to Phase I activities at OU8 are identified in Table 10.1.

10.1.2.2 Quality Assurance Reports to Management

A QA summary report will be prepared annually or at the conclusion of these activities (whichever is more frequent) by the EMD Quality Assurance Project Manager (QAPM) or designer. This report will include a summary of field operation and laboratory inspections, surveillance, and audits and a report on data verification/validation results.

10.1.3 Design Control and Control of Scientific Investigations

10.1.3.1 Design Control

The OU8 WP describes the investigation activities that will be implemented during the Phase I characterization of the OU8 IHSSs. The OU8 WP identifies the objectives of the investigations; specifies the sampling, analysis, and data generation requirements; and identifies applicable operating procedures that will provide controls for the investigations. As such, the OU8 WP is considered the investigation control plan for OU8 Phase I RFI/RI activities.

The disposition of investigation-derived waste is being developed through EG&G Environmental Operations Management (EOM) Department. EOM has been developing procedures for handling and disposal of investigation-derived wastes. These procedures are being reviewed by DOE, CDH and EPA. It is not necessary to discuss in detail the process in this work plan as the final procedure will cover all environmental field activities through SOPs or other documentation to be determined.

10.1.3.2 Data Quality Objectives

The development of DQOs for the OU8 Phase I investigations is presented in Section 5.0 of the OU8 WP The DQOs for OU8 were established in accordance with 3-stage process described in Data Quality Objectives for Remedial Response Activities (EPA, 1987), and Appendix A of the QAPjP (EG&G, 1991a).

Identifying data quality needs begins with defining investigation objectives and identifying data uses and the types of data to be collected. Phase 1 investigation objectives, data uses and DQOs for OU8 are defined in Section 5.0. Other factors that are necessary in identifying data quality needs include selecting appropriate analytical levels, contaminants of concern, levels of concern, required detection limits, and critical samples. The analytical levels, contaminants of concern, levels of concern, and required detection limits are presented in Section 5 of the OU8 WP.

Data quality can be measured in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. Precision, accuracy, and completeness are quantitative measures of data quality, while representativeness and comparability are qualitative statements that express the degree to which sample data represent actual conditions and describe the confidence of one data set to another. These parameters are defined in Appendix A of the QAPjP (EG&G, 1991a). PARCC parameters will be determined for OU8 Phase I investigations as described previously in Section 5. PARCC parameter goals are established prior to initiating investigations in order to assist decision makers in determining if DQOs for measurement data have been met. The goals for precision and accuracy for the contaminants of concern identified in Table 5.2 are presented in Table 10.2. The goal for completeness is 100 percent with a minimum acceptable completeness of 90 percent for laboratory measurement data and 80 percent for field measurements.

Based on the data quality needs identified for OU8 Phase I investigations, the sampling and analytical options were evaluated. The sampling and analytical methods selected for OU8 Phase I investigations are listed in Table 5.2. The specific field analytical methods and the Standard EPA and EPA CLP laboratory methods are identified in Table 10.2.

10.1.3.3 Sampling Locations and Sampling Procedures

The sampling plan for OU8 is described in Section 6 of the OU8 WP. Sampling activities will be staged, with the initial stages providing information that will be used to direct and refine sampling methods and location in subsequent stages.

The operating procedures that are applicable to OU8 Phase I field activities and the particular activities to which they are applicable are summarized in Table 10.1.

10.1.3.4 Analytical Procedures

The analytical program for OU8 Phase I RFI/RI investigation is discussed in Section 6.8.6. The analytes of interest and the specified detection limits for radiation surveys, surface scrape radiochemistry, soil gas sampling, subsurface (borehole) soil sampling, shallow soil sampling, alluvial groundwater sampling, asphalt sampling, and surface wipe sampling for each IHSS are identified in Table 6.3. The analytical methods that shall be adhered to are those that are specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B. These methods are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each analyte identified in Table 6.3 are referenced in Table 10.2.

10.1.3.5 Equipment Decontamination

Non-dedicated sampling equipment (i.e., sampling equipment that is used at more than one location) shall be decontaminated between sampling locations in accordance with OPS-FO.03, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, boring, well installation, sample collection, etc. shall be decontaminated as specified in OPS-FO.04, Heavy Equipment Decontamination.

10.1.3.6 Air Quality

Air monitoring will be conducted during implementation of field activities that have the potential to create windblown dispersion of contaminants, including drilling, coring, and installation of boreholes and monitoring wells. Air monitoring will ensure that OU8 RFI/RI activities comply with the RFP Interim Plan for Prevention of Contaminant Dispersion. Air monitoring will be conducted according to OPS-FO.01, Wind Blown Contaminant Dispersion Control.

10.1.3.7 Quality Control

To ensure the quality of the field sampling techniques, collection and/or preparation of field QC samples are incorporated into the sampling scheme. Field QC samples and collection frequencies for OU8 are addressed in Section 6.8.4 and are identified in Table 6.4. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 10-1) prior to sampling. The implementing subcontractor will be required to prepare and submit a specific sampling schedule. This schedule will include provisions for equipment rinsate blanks, etc. and approval must be obtained prior to beginning any sampling activities.

Objectives for Field QC Samples

Equipment rinsate blanks are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Table 5.3. Equipment rinsate blanks may only be analyzed if contaminants of concern are detected above background in samples. Field duplicate samples shall agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Trip blanks and field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Table 5.3. The Laboratory Analysis Task Leader (Figure 10-1) is responsible for verifying these criteria and shall be responsible for checking to see if they are met and for qualifying data.

Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency of analytical and storage procedures. The laboratory contractor will submit written SOPs to the Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with or equivalent to EPA-CLP QC procedures. The laboratory SOPs must cover the following areas in sufficient detail and reflect actual operating conditions in effect during analysis of EG&G RFP samples:

- Sample receipt and log-in
- Sample storage and security
- Facility security
- Sample tracking (from receipt to sample disposition)
- Sample analysis method references

- Data reduction, verification, and reporting
- Document control (including submitting documents to EG&G)
- Data package assembly (see Section III.A of the GRRASP)
- Qualifications of personnel
- Preparation of standards
- Equipment maintenance and calibration
- List of instrumentation and equipment (including date purchased, date installed, model number, manufacturer, and service contracts, if any)
- Instrument detection limits
- Acceptance criteria for non-CLP analyses
- Laboratory QC checks applicable to each analytical method

Laboratory QC techniques to ensure consistency and validity of analytical results (including detecting potential laboratory contamination of samples) include using reagent blanks, field blanks, internal standard reference materials, laboratory replicate analysis, and field duplicates. The laboratory contractor will follow the standard evaluation guidelines and QC procedures, including frequency of QC checks, that are applicable to the particular type of analytical method being used as specified in Parts A and B of the GRRASP and Section 3.0 of the QAPjP. All data packages will be forwarded to the Laboratory Analysis Task Leader or validation contractor (Figure 10-1) for review and verification.

10.1.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU8 WP, field inspections, audits, and surveillance will be conducted at various intervals. The intervals will be determined by the importance and complexity of each activity. Intervals will also be based on the schedule contained in Section 7.0. The field inspection referenced above and at a minimum, each of the field sampling activities described in Sections 6.4 will be monitored by an independent surveillance team at least once during the sampling process. EG&G will conduct audits of the laboratory contractor(s) as specified in the GRRASP, Parts A and B.

10.1.3.9 Data Reduction, Validation, and Reporting

Analytical Reporting Turnaround Times

Analytical reporting turnaround times are as specified in Table 3-1 of Section 3.0 of the QAPjP.

Data Reduction

Reduction of laboratory measurements shall be in accordance with the methods specified for each analytical method. Laboratory data will be compiled into sample data packages by the laboratory contractor. A sample data package shall be developed for each sample delivery group or sample batch, with separate data packages for each type of analysis (e.g., a data package for organics, one for inorganics, one for water quality parameters, and one for radionuclides). The sample data package shall consist of a cover sheet/transmittal letter, a case narrative, data summary forms, and copies of the data checklists found in Attachments I in Parts A and B of the GRRASP. The reduced data will be used in the data validation process to verify that the laboratory control and the overall system DQOs have been met.

Data Validation

Validation activities consist of reviewing and verifying field and laboratory data and evaluating these verified data for data quality (i.e., comparison of reduced data to DQOs, where appropriate). The field and laboratory data validation activities and guidelines are described and referenced in Section 3.0 of the QAPjP. The process for validating the quality of the data is illustrated graphically in Figure 3-1 of Section 3.0 of the QAPjP, and is also included as part of the sample collection, chain-of-custody, and analysis process illustrated in Figure 8-1 of Section 8.0 of the QAPjP. The criteria for determining the validity of ER data at Rocky Flats are described in subsection 3.3.7 of Section 3.0 of the QAPjP.

Data Reporting

Depending on the data validation process, data are flagged as either "valid," "acceptable with qualifications," or "rejected." The results of the data validation shall be reported in ER Department Data Assessment Summary reports. The usability of data (the criteria of which is also described in subsection 3.3.7 of Section 3.0 of the QAPjP shall also be addressed by the RFI Project Manager.

10.1 4 Procurement Document Control

Procurement documents for items and services, including services for conducting field investigations and analytical laboratories, shall be prepared, handled, and controlled in accordance with the requirements and methods specified in Section 4.0 of the QAPjP.

10.1.5 Instructions, Procedures, and Drawings

The OU8 WP describes the activities to be performed. The OU8 WP will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section 5.0 of the QAPjP.

EMD OPS approved for use are identified in Table 10.1, which also indicates their applicability. Any additional quality-affecting procedures proposed for use but not identified in Table 10.1 will be developed and approved as required by Section 5.0 of the QAPjP prior to performing the affected activity

Changes and variances to approved operating procedures shall be documented through preparation of Document Change Notices (DCNs), which will be prepared, reviewed, and approved in accordance with requirements specified in Section 5.0 of the QAPjP (Note: DCNs were referred to as Procedure Change Notices in Revision 0 of the QAPjP). Any changes, revisions, additions, or deletions to the OU8 WP will be presented in either DCNs or Technical Memoranda. DCNs and Technical Memoranda will be reviewed and approved by the same organizations that reviewed and approved the original OU8 WP.

10.1.6 Document Control

The following documents will be controlled in accordance with Section 6.0 of the QAPjP:

- "Phase I RFI/RI Work Plan for the 700 Area, Operable Unit No. 8"
- "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP)
- EMD Operating Procedures and EM Radiological Guidelines (all operating procedures specified in this QAA and to-be-developed laboratory SOPs).

10.1.7 Control of Purchased Items and Services

Contractors that provide services to support the OU8 WP activities will be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes preaward evaluation/audit of proposed contractors as well as periodic audit of the acceptability of contractor performance during the life of the contract. Any items or materials that are purchased for use during the OU8 investigations that have the ability to affect the quality of the data shall be inspected upon receipt.

10.1.8 Identification and Control of Items, Samples, and Data

10.1.8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for water and soil samples are presented in Table 6.3.

10.1.8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8.0 of the QAPjP and OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Samples shall have unique identification that traces the sample to the source(s) and indicates the method(s), date, the sampler(s), and conditions prevailing at the time of sampling.

10.1.8.3 Chain-of-Custody

Sample chain-of-custody will be maintained through the application of OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples, and as illustrated in Figure 8-1 of the QAPjP for all environmental samples collected during field investigations.

10.1.9 Control of Processes

The overall process of collecting samples, performing analysis, and inputting the data into a database is considered a process that requires control. The process is controlled through a series of written procedures that govern and document the work activities. A process diagram is shown in Section 8.0 of the QAPjP.

10.1.10 Inspection

Procured materials and construction activities (e.g., groundwater monitoring well installation) shall be inspected in accordance with the requirements specified in Section 10.0 of the QAPjP.

10.1.11 Test Control

Test control requirements specified in Section 11.0 of the QAPjP are not applicable to any of the RFI/RI investigations described in the OU8 WP.

10.1.12 Control of Measuring and Test Equipment (M&TE)

10.1.12.1 Field Equipment

Specific conductivity, temperature, and pH of groundwater samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in OPS-GW.05, Field Measurements for Groundwater Field Parameters. Measurements shall be made using EG&G approved equipment. Examples of equipment/instruments used to generate field measurements include:

- Temperature: mercury-filled, teflon-coated, safety-type thermometer (VWR catalogue No. 6107-832 or equivalent), or digital readout thermistor (VWR Catalogue No. 61017-562 or equivalent)
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter
- pH: HACH One pH Meter (this meter may also be used for temperature measurements)

In addition to the field measurements for water quality, field measurements (screening) for radiation, metals, and soil gas will also be made. The following instruments are planned to be used for these measurements.

- Radiological field readings for field survey grid locations. Beta/Gamma radiation will be measured with a Geiger-Muller shielded pancake detector, gamma radiation will be measured with an HPGe detector, and Alpha radiation will be measured by a side shielded FIDLER. Use, calibration, and maintenance shall be according to EMRG OPS-1.1, 1.2 and 3.2. Walk-over radiation screenings shall also be performed for worker health and safety using a side shielded FIDLER according to OPS-FO.16, Field Radiological Measurements.

- Field readings for soil gas will be taken using a portable photoionization detector (PID), HNU Systems P1-101, or equivalent. Use, calibration, and maintenance according to OPS-FO.15, PIDs and Flame Ionization Detectors (FIDs).
- Field screening at IHSS site for inorganics (i.e., metals) using a Portable X-Ray Fluorescence (FPXRF) Analyzer, Outokumpu Electronics HAZ-MET 880, or equivalent.

Each piece of field equipment shall have a file that contains:

- Specific model and instrument serial number
- Operating instructions
- Routine preventative maintenance procedures, including a list of critical spare parts to be provided or available in the field
- Calibration methods, frequency, and description of the calibration solutions
- Standardization procedures (traceability to nationally recognized standards).

The above information shall, in general, conform to the manufacturer's recommended operating instructions or shall explain the deviation from said instructions.

10.1.12.2 Laboratory Equipment

Laboratory analyses will be performed by contracted laboratories. The equipment used to analyze environmental samples shall be calibrated, maintained, and controlled in accordance with the requirements contained in the specific analytical protocols used as specified in the GRRASP. This information will be supplied to EG&G as a laboratory SOP.

10.1.13 Handling, Storage, and Shipping

Samples shall be packaged, transported, and stored in accordance with OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservative, sample volumes, and sample containers are specified in Table 8-1 of Section 8.0 of the QAPjP. Sample handling and storage controls at the laboratory shall be provided as a laboratory SOP.

10.1.14 Status of Inspection, Test, and Operations

The requirements for the identification of inspection, test, and operating status shall be implemented as specified in Section 14.0 of the QAPjP. A log specifying the status of all boreholes and groundwater monitoring wells shall be maintained by the Field Activities Task Leader, which will include well/borehole identification number, ground elevation, casing depth of hole, depth to bedrock, static water level (as applicable), depth to top and bottom of screen (as applicable), diameter of hole, diameter of casing, and top/bottom of casing.

10.1.15 Control of Nonconformances

The requirements for the identification, control, evaluation, and disposition of nonconforming items, samples, and data will be implemented as specified in Section 15.0 of the QAPjP. Nonconformances identified by the implementing contractor shall be submitted to EG&G for processing as outlined in the QAPjP.

10.1.16 Corrective Action

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section 16.0 of the QAPjP. Conditions adverse to quality identified by the implementing contractor shall be documented and submitted to EG&G for processing as outlined in the QAPjP.

10.1.17 Quality Assurance Records

QA records will be controlled in accordance with OPS-FO.02, Field Document Control. QA records to be generated during OU8 RFI/RI activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for groundwater, sediment, and air)
- Calibration Records
- Sample Collection and Chain-of-Custody Records
- Laboratory Sample Data Packages
- Drilling Logs
- Work Plan/Field Sampling Plan
- QAPjP/QAA
- Audit/Surveillance/Inspection Reports

- Nonconformance Reports
- Corrective Action Documentation
- Data Validation Results
- Data Reports
- Procurement/Contracting Documentation
- Training/Qualification Records
- Inspection Records

10.1.18 Quality Verification

The requirements for the verification of quality shall be implemented as specified in Section 18.0 of the QAPjP. EG&G will conduct audits of the laboratory contractor as specified in the GRRASP, Parts A and B. The EMD QAPM shall develop a surveillance schedule with the surveillance intervals based on the importance and complexity of each sampling/analytical activity Intervals will also be based on the schedule contained in Section 7.0.

Examples of some specific tasks that will be monitored by the surveillance program are as follows:

- Borings and well installations (approximately 10 percent of the holes)
- Field sampling (approximately 5 percent of each type of sample collected)
- Records management (a surveillance will be conducted once at the initiation of OU8 activities, and monthly thereafter)
- Data verification, validation, and reporting

Audits of contractors providing field investigation, construction, and analytical support services shall be performed at least annually or once during the life of the project, whichever is more frequent.

A Readiness Review shall be conducted by the EMD QAPM prior to the implementation of OU8 field investigation activities. The readiness review will determine if all activity prerequisites that are required to begin work have been met. The applicable requirements of the QAPjP and this QAA will be addressed during the readiness review.

10.1.19 Software Control

The requirements for the control of software shall be implemented as specified in Section 19.0 of the QAPjP. Only database software is anticipated to be used for the OU8 WP activities. Operating procedures applicable to the use of the database storing environmental data can be found in OPS-FO.14, Field Data Management.

TABLE 10.[illegible]

EMD Operating Procedures and Field Activities for Which They are Applicable

EMAD OPS Reference Numbers	Standard Operating Procedures	HPGe Surveys 1)	Sediment Sampling	Surface Water Sampling	Field Radiation Surveys	Well Drilling Completion, Development	Ground-Water Sampling	Soil-Gas Surveys	Surface Soil Sampling	Subsurface Soil Sampling	Test Pit Sampling
FO.01	Wind Blown Contaminant Dispersion Control								●		●
FO 02	Field Document Control	●			●	●	●	●	●	●	●
FO 03	General Equipment Decontamination	1)			●	●	●	●	●	●	●
FO 04	Heavy Equipment Decontamination					●	●		●	●	●
FO 05	Handling of Purge and Development Water					●	●				
FO 06	Handling of Personal Protective Equipment	X			●	●	●	●	●	●	●
FO 07	Handling of Decontamination Water & Wash Water	1)			●	●	●	●	●	●	●
FO 08	Handling of Drilling Fluids & Cuttings					●				●	
FO 09	Handling of Residual Samples								●	●	
FO 10	Receiving, Labeling, and Handling Waste Containers	1)				●	●			●	
FO 11	Field Communications	●			●	●	●	●	●	●	●
FO 12	Decontamination Facility Operations				●	●	●	●	●	●	●
FO 13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples	1)	●	●			●	●	●	●	●
FO 14	Field Data Management	●			●	●	●	●	●	●	●
FO 15	Use of PIDS and FIDS					X	X	X	X	X	X
FO 16	Field Radiological Measurements - Walk-Over Surveys	X			●	X	X	X	X	X	X
FO 18	Environmental Sample Radioactivity Content Screening	1)					●		●	●	●
GW 01	Water Level Measurements in Wells and Piezometers					●	●				
GW 02	Well Development					●					
GW.05	Field Measurements for Groundwater Field Parameters						●				
GW.06	Groundwater Sampling						●				

X - As required by H&S plan 1) - Includes Vertical Soil Profile Sampling

21/29

TABLE 10.1 (Continued)

EMD Operating Procedures and Field Activities for Which They are Applicable

EMAD OPS Reference Numbers	Standard Operating Procedures	HPGe Surveys 1)	Sediment Sampling	Surface-Water Sampling	Field Radiation Surveys	Well Drilling Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil Sampling	Subsurface Soil Sampling	Test Pit Sampling
GT 01	Logging Alluvial and Bedrock Material	1)				●				●	
GT 02	Drilling and Sampling Using Hollow-Stem Auger Tech.	1)				●				●	
GT 03	Isolating Bedrock from the Alluvium with Surface Casing					●				●	
GT 05	Plugging and Abandonment of Boreholes	1)				●				●	
GT 06	Monitoring Well and Piezometer Installation					●					
GT 07	Logging & Sampling of Test Pits & Trenches										●
GT 08	Surface Soil Sampling								●		
GT 09	Soil Gas Sampling and Field Analysis							●			
GT 10	Borehole Clearing	1)				●				●	
GT 15	Geophysical Borehole Logging					●				●	
GT 17	Land Surveying					●				●	
GT 19	Field Gas Chromatographs							●			
GT.22	BAT In-Situ Sampler (Proposed)						●				
GT 30	*In-Situ* Characterization of Radionuclides	●									
SW 03	Surface Water Sampling			●							
SW 04	Sediment Sampling		●								
1 1	Gamma Radiation Surveys	●			●						
1.2	Beta Radiation Surveys	●			●						
3.2	Survey Requirements for Conditional & Unrestricted Use	●			●						

22/29

TABLE 10.2

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

INDICATORS								
Total Organic Carbon	EPA 415[a]	X[e]		5 mg/L		20%RPD[f]	Recovery 80-120%	LCS
	ASTM D4129-82		X					
INORGANICS								
Target Analyte List - Metals		X[f]	X			WATER/SOIL	WATER/SOIL	
Aluminum	EPA CLP SOW[b]			200 ug/L[d]	40 mg/Kg[d]	**	***	
Antimony	EPA CLP SOW[b]			60	12			
Arsenic (GFAA)	EPA CLP SOW[b]			10	2			
Barium	EPA CLP SOW[b]			200	40			
Beryllium	EPA CLP SOW[b]			5	1 0			
Cadmium	EPA CLP SOW[b]			5	1 0			
Calcium	EPA CLP SOW[b]			5000	2000			
Chromium	EPA CLP SOW[b]			10	2 0			
Cobalt	EPA CLP SOW[b]			50	10			
Copper	EPA CLP SOW[b]			25	5 0			
Cyanide	EPA 335 3 (modified for CLP)[a,d]			5	10			
Iron	EPA CLP SOW[b]			100	20			
Lead (GFAA)	EPA CLP SOW[b]			3	1 0			
Magnesium	EPA CLP SOW[b]			5000	2000			
Manganese	EPA CLP SOW[b]			15	3 0			
Mercury (CVAA)	EPA CLP SOW[b]			0 2	0 2			
Nickel	EPA CLP SOW[b]			40	8 0			
Potassium	EPA CLP SOW[b]			5000	2000			
Selenium (GFAA)	EPA CLP SOW[b]			5	1 0			
Silver	EPA CLP SOW[b]			10	2 0			
Sodium	EPA CLP SOW[b]			5000	2000			
Thallium (GFAA)	EPA CLP SOW[b]			10	2 0			
Vanadium	EPA CLP SOW[b]			50	10			
Zinc	EPA CLP SOW[b]			20	4 0			

23/29

TABLE 10.2 - continued

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

ANIONS						Water/Soil	Water/Soil
Sulfate	EPA 375.4[4]		X				
Nitrate as N	EPA 353 2[4] or 353 3[4]	X[5]	X	1 mg/L		Same as Metals	Same as Metals
Fluoride	(TBD)		X				
Target Compound List - Volatiles		X[5]	X			WATER/SOIL	WATER/SOIL
Chloromethane	EPA CLP SOW[6]			10 ug/L	10 ug/Kg (low)[3]	**	***
Bromomethane	EPA CLP SOW[6]			10	10		
Vinyl Chloride	EPA CLP SOW[6]			10	10		
Chloroethane	EPA CLP SOW[6]			10	10		
Methylene Chloride	EPA CLP SOW[6]			5	5		
Acetone	EPA CLP SOW[6]			10	10		
Carbon Disulfide	EPA CLP SOW[6]			5	5		
1,1-Dichloroethene	EPA CLP SOW[6]			5	5		
1,1-Dichoroethane	EPA CLP SOW[6]			5	5		
total 1,2-Dichloroethene	EPA CLP SOW[6]			5	5		
Chloroform	EPA CLP SOW[6]			5	5		
1,2-Dichloroethane	EPA CLP SOW[6]			1	5		
2-Butanone	EPA CLP SOW[6]			10	10		
1,1,1-Trichoroethane	EPA CLP SOW[6]			5	5		
Carbon Tetrachloride	EPA CLP SOW[6]			5	5		
Vinyl Acetate	EPA CLP SOW[6]			10	10		
Bromodichloromethane	EPA CLP SOW[6]			5	5		
1,2-Dichloropropane	EPA CLP SOW[6]			5	5		
cis-1,3-Dichloropropene	EPA CLP SOW[6]			5	5		
Trichloroethene	EPA CLP SOW[6]			5	5		
Dibromochloromethane	EPA CLP SOW[6]			5	5		
1,1,2-Trichloroethane	EPA CLP SOW[6]			5	5		
Benzene	EPA CLP SOW[6]			5	5		
trans-1,2-Dichloropropene	EPA CLP SOW[6]			5	5		
Bromoform	EPA CLP SOW[6]			5	5		
4-Methyl-2-pentanone	EPA CLP SOW[6]			10	10		
2-Hexanone	EPA CLP SOW[6]			10	10		
Tetrachloroethene	EPA CLP SOW[6]			5	5		
Toluene	EPA CLP SOW[6]			5 ug/L	5 ug/KG	**	***
1,1,2,2-Tetrachoroethane	EPA CLP SOW[6]			5	5		
Chlorobenzene	EPA CLP SOW[6]			5	5		
Ethyl Benzene	EPA CLP SOW[6]			5	5		
Styrene	EPA CLP SOW[6]			5	5		
Total Xylenes	EPA CLP SOW[6]			5	5		
Target Compound List - Semi-Volatiles			X			SOIL	SOIL
Phenol	EPA CLP SOW[6]				330 ug/Kg[3]	**	***
bis(2-Chloroethyl)ether	EPA CLP SOW[6]				330		
2-Chlorophenol	EPA CLP SOW[6]				330		
1,3-Dichlorobenzene	EPA CLP SOW[6]				330		
1,4-Dichlorobenzene	EPA CLP SOW[6]				330		
Benzyl Alcohol	EPA CLP SOW[6]				330		
1,2-Dichlorobenzene	EPA CLP SOW[6]				330		

24/29

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

2-Methylphenol	EPA CLP SOW[a]		330		
bis(2-Chloroisopropyl)ether	EPA CLP SOW[a]		330		
4-Methylphenol	EPA CLP SOW[a]		330		
N-Nitroso-Dipropylamine	EPA CLP SOW[a]		330		
Hexachloroethane	EPA CLP SOW[a]		330		
Nitrobenzene	EPA CLP SOW[a]		330		
Isophorone	EPA CLP SOW[a]		330		
2-Nitrophenol	EPA CLP SOW[a]		330		
2,4-Dimethylphenol	EPA CLP SOW[a]		330		
Benzoic Acid	EPA CLP SOW[a]		1600		
bis(2-Chloroethoxy)methane	EPA CLP SOW[a]		330		
2,4-Dichlorophenol	EPA CLP SOW[a]		330		
1,2,4-Trichlorobenzene	EPA CLP SOW[a]		330		
Naphthalene	EPA CLP SOW[a]		330		
4-Chloroanaline	EPA CLP SOW[a]		330		
Hexachlorobutadiene	EPA CLP SOW[a]		330		
4-Chloro-3-methylphenol	EPA CLP SOW[a]		330		
2-Methylnaphthalene	EPA CLP SOW[a]		330		
Hexachlorocyclopentadiene	EPA CLP SOW[a]		330		
2,4,6-Trichlorophenol	EPA CLP SOW[a]		330		
2,4,5-Trichlorophenol	EPA CLP SOW[a]		1600 ug/Kg[3]	**	***
2-Chloronaphthalene	EPA CLP SOW[a]		330		
2-Nitroanaline	EPA CLP SOW[a]		1600		
Dimethylphthalate	EPA CLP SOW[a]		330		
Acenaphthylene	EPA CLP SOW[a]		330		
2,6-Dinitrotoluene	EPA CLP SOW[a]		330		
3-Nitroaniline	EPA CLP SOW[a]		1600		
Acenaphthene	EPA CLP SOW[a]		330		
2,4-Dinitrophenol	EPA CLP SOW[a]		1600		
4-Nitrophenol	EPA CLP SOW[a]		1600		
Dibenzofuran	EPA CLP SOW[a]		330		
2,4-Dinitrotoluene	EPA CLP SOW[a]		330		
Diethylphthalate	EPA CLP SOW[a]		330		
4-Chlorophenol Phenyl ether	EPA CLP SOW[a]		330		
Fluorene	EPA CLP SOW[a]		330		
Target Compound List - Semi-Volatiles (continued)		x			
4-Nitroanaline	EPA CLP SOW[a]		1600 ug/Kg[3]	**	***
4,6-Dinitro-2-methylphenol	EPA CLP SOW[a]		1600		
N-nitrosodiphenylamine	EPA CLP SOW[a]		330		
4-Bromophenyl Phenyl ether	EPA CLP SOW[a]		330		
Hexachlorobenzene	EPA CLP SOW[a]		330		
Pentachlorophenol	EPA CLP SOW[a]		1600		
Phenanthrene	EPA CLP SOW[a]		330		
Anthracene	EPA CLP SOW[a]		330		
Di-n-butylphthalate	EPA CLP SOW[a]		330		
Fluoranthene	EPA CLP SOW[a]		330		
Pyrene	EPA CLP SOW[a]		330		
Butyl Benzylphthalate	EPA CLP SOW[a]		330		
3,3'-Dichlorobenzidine	EPA CLP SOW[a]		660		
Benzo(a)anthracene	EPA CLP SOW[a]		330		
Chrysene	EPA CLP SOW[a]		330		
bis(2-ethylhexyl)phthalate	EPA CLP SOW[a]		330		

TABLE 10.2 - continued

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Di-n-octyl Phthalate	EPA CLP SOW*				330		
Benzo(b)fluoranthene	EPA CLP SOW*				330		
Benzo(k)fluoranthene	EPA CLP SOW*				330		
Benzo(a)pyrene	EPA CLP SOW*				330		
Indeno(1,2,3-cd)pyrene	EPA CLP SOW*				330		
Dibenz(a,h)anthracene	EPA CLP SOW*				330		
Benzo(g,h,i)perylene	EPA CLP SOW*				330		
RADIONUCLIDES						(Replicate Analyses) **	(Laboratory Control Sample) ***
Gross Alpha	e,f,g,h,i,k,l,m,n		X	NA	4 pCi/g		
Gross Beta	e,f,g,h,i,k,l,m,n		X	NA	10 pCi/g		
Uranium 233+234	f,h,i,m,n,s,l	X*	X	0 6 pCi/L	0 3 pCi/g		
Uranium 235,238	f,h,i,m,n,s,l		X	NA	0.3 pCi/g		
Americium 241	p,q,s,l,i		X	NA	0 02 pCi/g		
Plutonium 239+240	o,p,s,l,i	X*	X	0 01 pCi/L	0.03 pCi/g		
Tritium	f,g,h,m,s,i,l	X*	X	400 pCi/L	400 pCi/L		
Strontium 89,90	f,h,i,m,s,l		X	NA	1 pCi/g		
FIELD MEASUREMENTS							
1,1,1 Trichloroethane	EPA 502 2		X	5 ug/L	35% RPD		
Carbon tetrachloride	EPA 502.2		X	5 ug/L	35% RPD		
Methylethylketone	EPA 502 2		X	10 ug/L	35% RPD		
Dichloromethane	EPA 502 2		X	5 ug/L	35% RPD		
Perchloroethene	EPA 502 2		X	5 ug/L	35% RPD		
Trichloroethene	EPA 502 2		X	5 ug/L	35% RPD		
Benzene	EPA 502 2		X	5 ug/L			
Toluene	EPA 502 2		X	5 ug/L			
Xylene	EPA 502 2		X	5 ug/L			

26/29

27/29

TABLE 10.2 - continued

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

					Detection Limit	Precision	Accuracy
FIELD PARAMETERS							
	pH	1	X		± 0 1 pH unit	NA	± 0 2 pH units
	Specific Conductance	1	X		2 5 umho/cm[7] 25 umho/cm[8] 250 umho/cm[9]	NA NA NA	± 2 5% max error at 500, 5000, 50000 umhos/cm plus probe; ± 3 0% max error at 250, 2500, and 25000 plus probe accuracy of ± 2 0%
	Temperature	1	X		± 0 1°C	NA	± 1 0°C
	Beta/Gamma	Geiger Muller Detector		X	5,000 dpm/100cm²	± 20% Error	NA
	Alpha Radiation	FIDLER		X	300 dpm/100cm²	± 20% Error	NA

TABLE 10.2 - continued

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

** Precision objective = control limits specified in referenced method and/or Data Validation Guidelines
*** Accuracy objective = control limits specified in referenced method (in GRRASP for radionuclides)
F = Filtered
U = Unfiltered

1 Measured in the field in accordance with instrument manufacturer's instructions The instruments to be used are specified in Section 12

2 Medium soil/sediment required detection limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment required detection limit.

3 Detection limits listed for soil/sediment are based on wet weight The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

4 Higher detection limits may only be used in the following circumstance: If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the required detection limit This is illustrated in the example below:

For lead:

Method in use - ICP
Instrument Detection Limit (IDL) - 40
Sample Concentration - 220
Required Detection Limit (RDL) - 3

The value of 220 may be reported even though the instrument detection limit is greater than the RDL.

Note: The specified detection limits are based on a pure water matrix The detection limits for samples may be considerably higher depending on the sample matrix.

5 If gross alpha > 5 pCi/L, analyze for Radium 226; if Radium 226 > 3 pCi/L, analyze for Radium 228

6 The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4 14, Appendix Lower Limit of Detection, pg 21, and follow:

$$LLD = \frac{4.66\ (BKG/BKG\ DUR)^{1/2}}{(2\ 22)(Eff)(CR)(SR)(e^{-\lambda t})(Aliq)}$$

$$MDA = \frac{4\ 66\ (BKG/Sample\ DUR)^{1/2}}{(2\ 22)(Eff)(CR)(SR)e^{\lambda t}(Aliq)}$$

Where:

LLD = Lower Limit of Detection in pCi per sample unit.

BKG = Instrument Background in counts per minute (CPM).
Eff = Counting efficiency in cpm/disintegration per minute (dpm)
CR = Fractional radiochemical yield.
SR = Fractional radiochemical yield of a known solution.
λ = The radioactive decay constant for the particular radionuclide
t = The elapsed time between sample collection and counting
Aliq = Sample volume
BKG DUR = Background count duration in minutes

MDA = Minimum Detectable Actiwity in pCi per sample unit
BKG = same as for LLD
EFF = same as for LLD
CR = same as for LLD
SR = same as for LLD
λ = same as for LLD
t = same as for LLD
Aliq = same as for LLD
Sample DUR = sample count duration in minutes

7 On 500 umho/cm range.
8 On 5000 umho/cm range.
9 On 50000 umho/cm range.
a U S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version).
b U S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version). The specific method to be utilized is at the laboratory's discretion provided it meets the specified detection limit
c U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, 2/88 (or latest version).
d Methods are from "Methods for Chemical Analysis of Water and Wastes," U.S Environmental Protection Agency, 1983, unless otherwise indicated
e Methods are from "Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods," (SW-846, 3rd Ed.), U S Environmental Protection Agency

28/29

TABLE 10.2 - continued

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

f U S Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No EMSL-LY-0539-1, Las Vegas, NV, U S. Environmental Protection Agency.

g American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985 Standard Methods for the Examination of Water and Wastewater, 16th ed , Washington, D.C., Am Public Health Association

h U S. Environmental Protection Agency, 1976 Interim Radiochemical Methodology for Drinking Water, Report No EPA-600/4-75-008 Cincinnati U S Environmental Protection Agency.

i. Harley, J H., ed., 1975, ASL Procedures Manual, HASL-300; Washington, D.C., U.S. Energy Research and Development Administration

j U S EPA, 1982. "Methods for Organic Analysis of Municipal and Industrial Waste Water," US EPA-600/4-82-057.

k. "Handbook of Analytical Procedures," USAEC, Grand Junction Lab. 1970, page 196

l "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U S. Environmental Protection Agency, Cincinnati, Ohio 45268.

m "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," U.S G.S. Book 5, Chapter A5, 1977

n "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U S EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979

o "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium, and Americium," by E H Essington and B J Drennon, Los Alamos National Laboratory, a private communication

p "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories

q "Radioactivity in Drinking Water," EPA 570/9-81-002

r If the sample or duplicate result is <5 x IDL, then the control limit is ± IDL

s U S EPA, 1987 "Eastern Environmental Radiation Facility Radiochemistry Procedures Manual," EPA-520/5-84-006

29/29

INFORMATION ONLY

Approved by:

[signature]	6/28/94	[signature]	6/28/94
Manager, Remediation Programs		RFI Project Manager	

11.0 REFERENCES

ASI, 1991a: Advanced Sciences, Inc., "Non-Point Source Assessment and Storm-Sewer Infiltration/Inflow and Exfiltration Study," Rocky Flats Plant Site: Prepared for EG&G Rocky Flats, Inc., Tasks 2 and 3 of the Zero-Offsite Water-Discharge Study, Appendices A through G, 66 p., 15 figures, 10 tables, September 30, 1991.

ASI, 1991b: Advanced Sciences, Inc., "Storm-Runoff Quantity for Various Storm Events," Rocky Flats Plant Site, Task 6 of the Zero-Offsite Water Discharge Study; Prepared for EG&G, Rocky Flats, Inc.

ASI, 1991c: Advanced Sciences, Inc., "Sanitary Sewer Infiltration/Inflow and Exfiltration Study," Rocky Flats Plant Site, Task 1 of the Zero-Offsite Water-Discharge Study: Prepared for EG&G Rock Flats, Inc., September 30, 48p., 10 tables, 24 figures, and 3 appendices (A through C).

ASI, 1991: Advanced Sciences, Inc., "Non-Tributary Ground-Water Study," Rocky Flats Plant: Zero-Offsite Water-Discharge Study, May 21, 1991.

ASI, 1991: Advanced Sciences, Inc., "Temporary Water-Storage Capabilities Study," Rocky Flats Plant Site, Task 21 of the Zero-Offsite Water Discharge Study, 116 p., 12 figures, 45 tables, and 3 appendices, March 19, 1991.

ASTM, 1991: American Society of Testing Materials, "1991 Annual Book of Standards, Volume 04.08 Soil and Rock; Building Stones; Geotextiles," ASTM 1916 Race Street, Philadelphia, Pennsylvania.

Baker, 1973: V. R. Baker, "Paleosol Development in Quaternary Alluvium Near Golden, Colorado," The Mountain Geologist, Volume 10, No. 4, pp. 127-133, 1973.

CDH, 1992: Letter dated April 21, 1992 from Colorado Department of Health and United States Environmental Protection Agency to Frazer Lockhart, U.S. Department of Energy, regarding Modification to Work in the IAG.

Dames and Moore, 1981: Dames and Moore, "Geologic and Seismologic Investigations for Rocky Flats Plant," Contract DE-AC04-80A110890, 1981.

Davis, 1986: J.C. Davis, "Statistics and Data Analysis in Geology": Second Edition, John Wiley & Sons, New York, 1986.

DOE, 1980 United States Department of Energy, United States Department of Energy, "Final Environmental Impact Statement: Rocky Flats Plant Site, Golden, Jefferson County, Colorado," Volumes 1, 2, and 3, Washington, D.C., DOE/EIS-0064, 1980.

DOE, 1986: United States Department of Energy, "Comprehensive Environmental Assessment and Response Program Phase I: Draft Installation Assessment Rocky Flats Plant." Washington: U.S. Department of Energy. Unnumbered draft report, 1986.

DOE, 1986a: RI, United States Department of Energy, "Geological and Hydrological Data Summary," Rocky Flats Plant, Golden, Colorado, RI, 58 pp., July 21, 1986.

DOE, 1990: United States Department of Energy, "1989 Population, Economic and Land Use Data Base for Rocky Flats Plant, Golden, Colorado," 1991.

DOE, 1991: United States Department of Energy, "Federal Facility Agreement and Consent Order (IAG), DOE, EPA, and CDH," Washington, D.C., January 22, 1991.

DOE, 1991: United States Department of Energy, Technical Memorandum 1, Final Phase II RCRA Facility Investigation, Work Plan (Alluvial), Rocky Flats Plant, 902 Pad, Mound, and East Trenches Area (Operable Unit No. 2), Environmental Restoration Program, Rocky Flats Office, Golden, Colorado, 1991.

DOE, 1992a: United States Department of Energy, "Historical Release Report for the Rocky Flats Plant," Environmental Restoration Program, January 1992.

DOE, 1992b: United States Department of Energy, "Historical Release Report for the Rocky Flats Plant," Environmental Restoration Program, Manual 21100-Te-12501.01, Volumes I and II, June, 1992.

Doty & Associates, 1992a: Doty & Associates, Inc., "OU8 IHSS Descriptions": Prepared for Advanced Sciences, Inc., 1992.

Doty & Associates, 1992b: Doty & Associates, Inc., "Evaluation of 0-3 Pump Test, Woman Creek Alluvium, Rocky Flats Plant, January 13, 1992.

EG&G, 1990a. EG&G Rocky Flats, Inc., "Wetlands Assessment, Rocky Flats Site Revision C," 1990.

EG&G, 1990b EG&G Rocky Flats, Inc., "Background Geochemical Characterization Report, Rocky Flats Plant for 1989": Prepared for the U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, 6 sections, 34 figures, 81 tables, 3 plates, and Appendices A through D, December 21, 1990.

EG&G, 1990c: EG&G Rocky Flats, Inc., "First Draft Phase I RFI/RI Work Plan, Operable Unit No. 5": Prepared for U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, 7 sections, 7 figures, 6 tables, 2 plates, Appendices A-E, July, 1990.

EG&G, 1991a: EG&G Rocky Flats, Inc., "Quality Assurance Project Plan for CERCLA Remedial Investigations and Feasibility Studies and RCRA Facility Investigations and Corrective Measures Studies Activities," Environmental Restoration Program, 1991.

EG&G, 1991b: EG&G Rocky Flats, Inc., "EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol, Parts A & B (GRRASP)," Environmental Management Department, 1991.

EG&G, 1991c: EG&G Rocky Flats, Inc., "Draft Final Geologic Characterization Report," with Appendices, July 31, 1991.

EG&G, 1991d. EG&G Rocky Flats, Inc., "Surface Water and Sediment Monitoring Plan," Environmental Restoration Program, 81 p., 5 figures, 10 tables, and 2 plates, February 15, 1991.

EG&G, 1991e: EG&G Rocky Flats, Inc., "Radiological Guidelines Manual," No. 3-21000-SOPS-EMRG, Environmental Management Department, 1991.

EG&G, 1991f: EG&G Rocky Flats, Inc., "Draft, Rocky Flats Surface Water Management Plan," Prepared for U.S. Department of Energy, Rocky Flats Area Office, Volumes I and II, March 1991.

EG&G, 1991g: EG&G Rocky Flats, Inc., "Final Groundwater Protection and Monitoring Program Plan for Rocky Flats Plant," in compliance with DOE Order 5400.1, 9 sections, 1 plate, 31 figures, 20 tables, and Appendices A through E, November 27, 1991.

EG&G, 1991h: EG&G Rocky Flats, Inc., "Rocky Flats Plant Geologic Characterization Report", July 31, 1991

EG&G, 1991i. EG&G Rocky Flats, Inc., "Phase II RFI/RI Work Plan (Bedrock), 903 Pad, Mound, and East Trenches Areas (Operable Unit No. 2)," U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June 27, 1991.

EG&G, 1991j. EG&G Rocky Flats Plant, Inc., "Assessment of Known Suspect and Potential Environmental Releases of PCBs", Preliminary Assessment, Site Description, 1991.

EG&G, 1991k: EG&G Rocky Flats, Inc., "Rocky Flats Plant Site Environmental Report for 1990", RFP-ENV-90, 210p., 39 figures, 55 tables, 1991.

EG&G, 1991l: EG&G Rocky Flats, Inc., "Rocky Flats Plant Air Quality Management Plan", June 1991.

EG&G, 1991m: EG&G Rocky Flats, Inc., "EG&G Rocky Flats Plant Environmental Management Division Operating Procedures Manual," September 1991.

EG&G, 1992a: EG&G Rocky Flats, Inc., RFEDS - Selected Data Retrieval for OU 13; Received March 23, 1992, 11 sections, March 19, 1992.

EG&G, 1992b: EG&G Rocky Flats, Inc., "Final Phase I RFI/RI Work Plan for Original Process Waste Lines (Operable Unit 9)," Volumes 1 and 2, Environmental Restoration Program, February 19, 1992.

EG&G, 1992c: EG&G Rocky Flats, Inc., "Operating Procedures, Volume I, Field Operations," No. 521000, SOPS-FO, Environmental Management Department, 1992.

EG&G, 1992d: EG&G Rocky Flats, Inc., "Operating Procedures, Volume III, Geotechnical," No. 521000, SOPS-GT, Environmental Management Department, 1992.

EG&G, 1992e: EG&G Rocky Flats, Inc. "Operating Procedures, Volume I, Surface Water," No. 521000, SOPS-GT, Environmental Management Department, 1992.

EG&G, 1992f: EG&G Rocky Flats, Inc., "Operating Procedures, Vol. II, Groundwater," No. 521000, SOPS-GW, Environmental Management Department, 1992.

EG&G, 1992g: EG&G Rocky Flats, Inc., "Environmental Evaluation Technical Memorandum, Addendum to Final Phase I RFI/RI Work Plan (Original Process Waste Lines, Operable Unit 9)", June 1992.

EG&G, 1992h EG&G Rocky Flats, Inc., "Draft Final Phase II RFI/RI Aquifer Test Report, 903 Pad, Mound, and East Trenches Areas (Operable Unit No. 2)", August 14, 1992.

EG&G, 1992i: EG&G Rocky Flats, Inc., "Drainage and Flood Control Master Plan, Woman Creek, Walnut Creek, Upper Big Dry Creek and Rock Creek", April, 1992.

EG&G, 1992j: EG&G Rocky Flats, Inc., "Phase II Geologic Characterization - Data Acquisition Surface Geologic Mapping of the Rocky Flats Plant and Vicinity, Jefferson and Boulder Counties, Colorado", Final Report, March 1992.

EPA, 1981. United States Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards." 40 CFR Part 50, Subchapter C - Air Programs, Washington, D.C., 1981.

EPA, 1985: United States Environmental Protection Agency, "Development of Statistical Distribution or Ranges of Standard Factors Used in Exposure Assessments," Office of Research and Development, Washington, D.C.

EPA, 1987: United States Environmental Protection Agency, "Data Quality Objectives for Remedial Response Actions," CDM Federal Programs Corporation, 1987.

EPA, 1987a. United States Environmental Protection Agency, "Data Quality Objectives for Remedial Response Activities", Development Process: EPA/540/G-87/003, OSWER Directive 9355.0-7B.

EPA, 1987b: United States Environmental Protection Agency, "Date Quality Objectives for Remedial Response Activities, Example Scenario: RI/FS Activities at a Site with Contaminated Soils and Groundwater", EPA/540/G-87/004, OSWER Directive 9355.0-7B

EPA, 1988a: United States Environmental Protection Agency, Interim Final, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," Washington, D.C., EPA/540/G-89/004, OSWER Directive 9355.3.01, October 1988.

EPA, 1988b United States Environmental Protection Agency, "Federal Guidance Report Number 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Washington, D.C., EPA Office of Radiation Programs, EPA/520/1-88/020, 1988.

EPA, 1988c: United States Environmental Protection Agency, "Superfund Exposure Assessment Manual," Washington, D.C., EPA, Office of Emergency and Remedial Response, EPA/540/1-88/001, 1988.

EPA, 1989a: United States Environmental Protection Agency, Interim Final, "RCRA Facility Investigation (RFI) Guidance," Washington, D.C., EPA/530/SW-89-031, May 1989

EPA, 1989b: United States Environmental Protection Agency, "Methods for Evaluating the Attainment fo Cleanup Standards, Volume 1: Soil and Solid Media", Office of Policy, Planning, and Evaluation, EPA 230/02-88-042.

EPA, 1989c: United States Environmental Protection Agency, "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)", Interim final. EPA/540/1-899/002. Office of Emergency and Remedial Response, Washington, D.C. 1989.

EPA, 1989d: United States Environmental Protection Agency, "Exposure Factors Handbook", Washington, D.C., Office of Health and Environmental Assessment, EPA/600/8-89/043, 1989.

EPA, 1989e: United States Environmental Protection Agency, "Risk Assessment Guidance for Superfund Volume II, Environmental Evaluation Manual," Interim Final, Washington, D.C., EPA, Office of Emergency and Remedial Response, EPA/540/1-89/002, 1989.

EPA, 1990. United States Environmental Protection Agency, "Guidance for Data Useability in Risk Assessment", Interim Final, EPA/540/G-90/008.

EPA, 1991: United States Environmental Protection Agency, "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites," Washington, D.C., EPA, 540/P-91/001, 1991.

Gilbert, 1987. R.O. Gilbert, "Statistical Methods for Environmental Pollution Monitoring," Van Nostrand Reinhold Company Inc., New York, New York, 1987.

Hurr, 1976. R.T. Hurr, "Hydrology of Nuclear-Processing Plant Site, Rocky Flats, Jefferson County, Colorado," Open File Report 76-268. U.S.G.S., Denver, Colorado, March, 1976.

Hydro-Search, 1985: Hydro-Search, Inc., "Hydrogeologic Characterization of the Rocky Flats Plant, Golden, Colorado," Project No. 1520, 55 pp., 1985.

Hydro-Search, 1986: Hydro-Search, Inc., "Electromagnetic Survey, Rocky Flats Plant, Golden, Colorado," 1986.

LWA, 1987: Lee Wan and Associates, "Instruction Manual for Site Drainage Computer Model," Rocky Flats Plant Site: 24 p., February 1987.

Malde, 1955: H.E. Malde, "Surficial Geology of Louisville Quadrangle, Colorado," U.S. Geological Survey Bulletin 996-E, pp. 217-259, 1955.

Office of Federal Register, 1990, National Archives and Records Administration, Federal Register, March 8, 1990, p. 8709.

Robson, S.G., 1983, Hydraulic Characteristic of the Principal Bedrock Aquifers in the Denver Basin, Colorado: U.S.G.S. Hydrologic Investigations Atlas HA-659, scale 1:500,000, 3 sheets.

Rockwell, 1975: Rockwell International, "Annual Environmental Monitoring Report, January-December 1974," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-74, 1975.

Rockwell, 1976: Rockwell International, "Annual Environmental Monitoring Report, January-December 1975," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-75, 1976.

Rockwell, 1977. Rockwell International, "Annual Environmental Monitoring Report, January-December 1976," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-76, 1977.

Rockwell, 1978: Rockwell International, "Annual Environmental Monitoring Report, January-December 1977," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-77, 1978.

Rockwell, 1979. Rockwell International, "Annual Environmental Monitoring Report, January-December 1978," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-78, 1979

Rockwell, 1980: Rockwell International, "Annual Environmental Monitoring Report, January-December 1979," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-79, 1980.

Rockwell, 1981. Rockwell International, "Annual Environmental Monitoring Report, January-December 1980," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-80, 1981.

Rockwell, 1982. Rockwell International, "Annual Environmental Monitoring Report, January-December 1981," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-81, 1982.

Rockwell, 1983: Rockwell International, "Annual Environmental Monitoring Report, January-December 1982," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-82, 1983.

Rockwell, 1984: Rockwell International, "Annual Environmental Monitoring Report, January-December 1983," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-83, 1984.

Rockwell, 1985: Rockwell International, "Annual Environmental Monitoring Report, January-December 1984," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-84, 1985.

Rockwell, 1986a: Rockwell International, "Annual Environmental Monitoring Report, January-December 1985," Golden, Colorado: Rockwell International, Rocky Flats Plant, Report RFP-ENV-85, 1986.

Rockwell, 1986b: Rockwell International, "Draft Work Plan, Geological and Hydrological Site Characterization, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado." Golden, Colorado: Rockwell International, Rocky Flats Plant, 1986.

Rockwell, 1986c: Rockwell International, "Draft Project Operations Plan, Geological and Hydrological Site Characterization, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado," Golden, Colorado: Rocky Flats Plant, 1986.

Rockwell, 1986d: Rockwell International, "Resource Conservation and Recovery Act Part B - Post-Closure Care Permit Application for U.S. Department of Energy Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes." U.S. Department of Energy. Unnumbered Report, 1986.

Rockwell, 1986e: Rockwell International, "Geological and Hydrological Data Summary, U.S.Department of Energy, Rocky Flats Plant, Golden, Colorado," Golden, Colorado: Rockwell International, 58 pp., July 21, 1986.

Rockwell, 1986f: Rockwell International: "RCRA 3004 (U) Waste Management Units, Volume I," 1986.

Rockwell, 1987: Rockwell International, "Resource Conservation and Recovery Act Part B - Operating Permit Application for the U.S. DOE Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes, Revision 1," U.S. Department of Energy. Unnumbered Report.

Rockwell, 1988: Rockwell International," RCRA Post-Closure Permit Care, U.S. Department of Energy, Hazardous and Radioactive and Mixed Waste," Volume 2, Plate E-6, October 5, 1988.

Rockwell, 1989a: Rockwell International, "RCRA Closure Plan Tanks T-40, T-66, T-67, T-68, Hazardous Waste Management Unit," 1989.

Rockwell, 1989b: Rockwell International, "Rocky Flats Plant Site Environmental Report for 1988, May 1989.

Rockwell, 1989c: Rockwell International, "1988 Annual RCRA Ground-Water Monitoring Report for Regulated Units at Rocky Flats Plant," 2 Volumes, 1989.

Schleicher and Schuell, 1982: Schleicher and Schuell, Publication No. 500, Innovative Products for Separation Science, March 1982.

Scott, 1960: G.R. Scott, "Quaternary Sequence East of the Front Range Near Denver, Colorado," U.S. Geological Survey Professional Paper 700-C, pp. C11-C18, 1970.

Scott, 1963: G.R. Scott "Quaternary Geology and Geomorphic History of the Kassler Quadrangle, Colorado," U.S. Geological Survey Professional Paper 421-A, 1963.

Scott, 1970: G.R. Scott, "Quaternary Faulting and Potential Earthquakes in East-Central Colorado," U.S. Geological Survey Miscellaneous Geologic Inventory Map I-790-A, 1972.

Scott, 1972: G.R. Scott, "Geologic Map of the Morrison Quadrangle, Jefferson County, Colorado," U.S. Geological Survey Miscellaneous Geologic Inventory Map I-790-A, 1972.

Scott, 1975: G.R. Scott, "Cenozoic Surfaces and Deposits in the Southern Rocky Mountains" in Cenozoic History of the Southern Rocky Mountains, B.F. Curtis, ed., Geological Society of America Memoir 144, pp. 227-248, 1975.

SCS, 1983: Soil Conservation Service, "Soil Survey of Golden Area, Colorado," U.S. Department of Agriculture, Jefferson County, Colorado, 167-S/304, 1983.

Spencer, 1961. F.D. Spencer, "Bedrock Geology of the Louisville Quadrangle, Colorado," U.S. Geological Survey Geologic Quadrangle Map GQ-151, 1961.

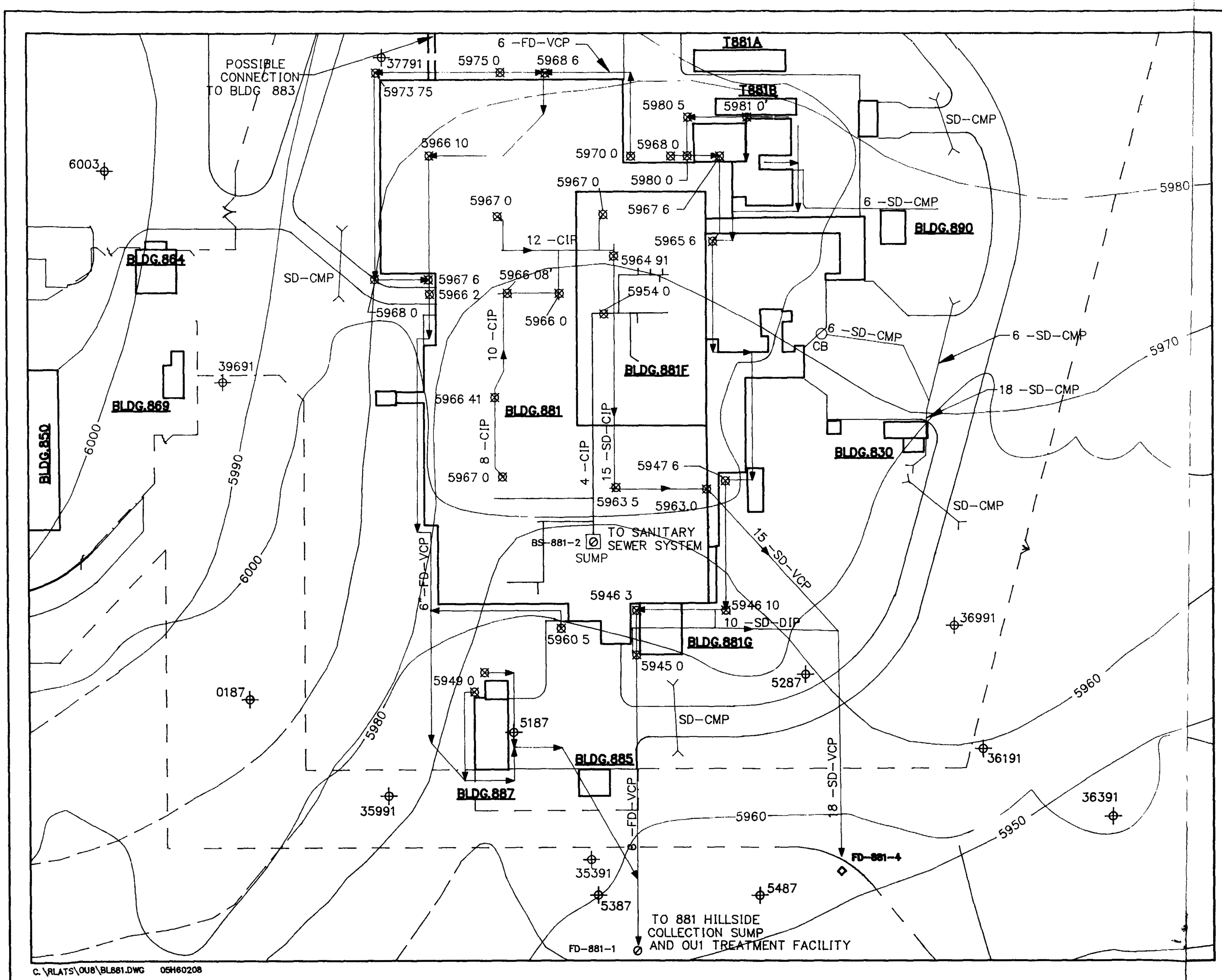
Tracer, 1986: Tracer Research, Inc., "Shallow Soil Gas Investigation of the Rocky Flats Plant, Golden, Colorado," 1986.

Van Genuchten, M.Th., The RETC Lode for Quantifying the Hydraulic Functions of Unsaturated Soils, EPA/600/2-91/065, December 1991.

Van Horn, 1972: R. Van Horn, "Surficial and Bedrock Geologic Map of the Golden Quadrangle, Jefferson County, Colorado," U.S. Geological Survey Miscellaneous Geological Field Inventory Map 1-781-A, 1972.

Van Horn, 1976: R. Van Horn, "Surficial and Bedrock Geologic Map of the Golden Quadrangle, Jefferson County, Colorado," U.S. Geological Survey Miscellaneous Geological Field Inventory Map 1-781-A, 1972.

Weimer, 1973: R.J. Weimer, "A Guide to Uppermost Cretaceous Stratigraphy, Central Front Range, Colorado: Del Taic Sedimentation, Growth Faulting, and Early Laramide Crustal Movement," The Mountain Geologist, Volume 10, No.3, pp. 53-97, July 1973.



U S Department of Energy
Rocky Flats Plant

EXPLANATION DRAFT

Buildings
Foundation Drain
Storm Drain
Utility Tunnel
Sump

FD	Foundation Drain
SD	Storm Drain
VCP	Vitrified Clay Pipe
CMP	Corrugated Metal Pipe
DIP	Ductile Iron Pipe
PVC	PVC Pipe
CIP	Cast Iron Pipe

Fences
Roads
Tunnel
Ditch

Elevation Point
Outfall
Sample Station (Current)
Sample Station (Historical)
Sample Station (Proposed)
Station Never Sampled
Alluvial Monitoring Well
Bedrock Monitoring Well
5960 Topographic Elevation
5950 Water Table Elevation Spring 1992

0 FEET 50 100 150

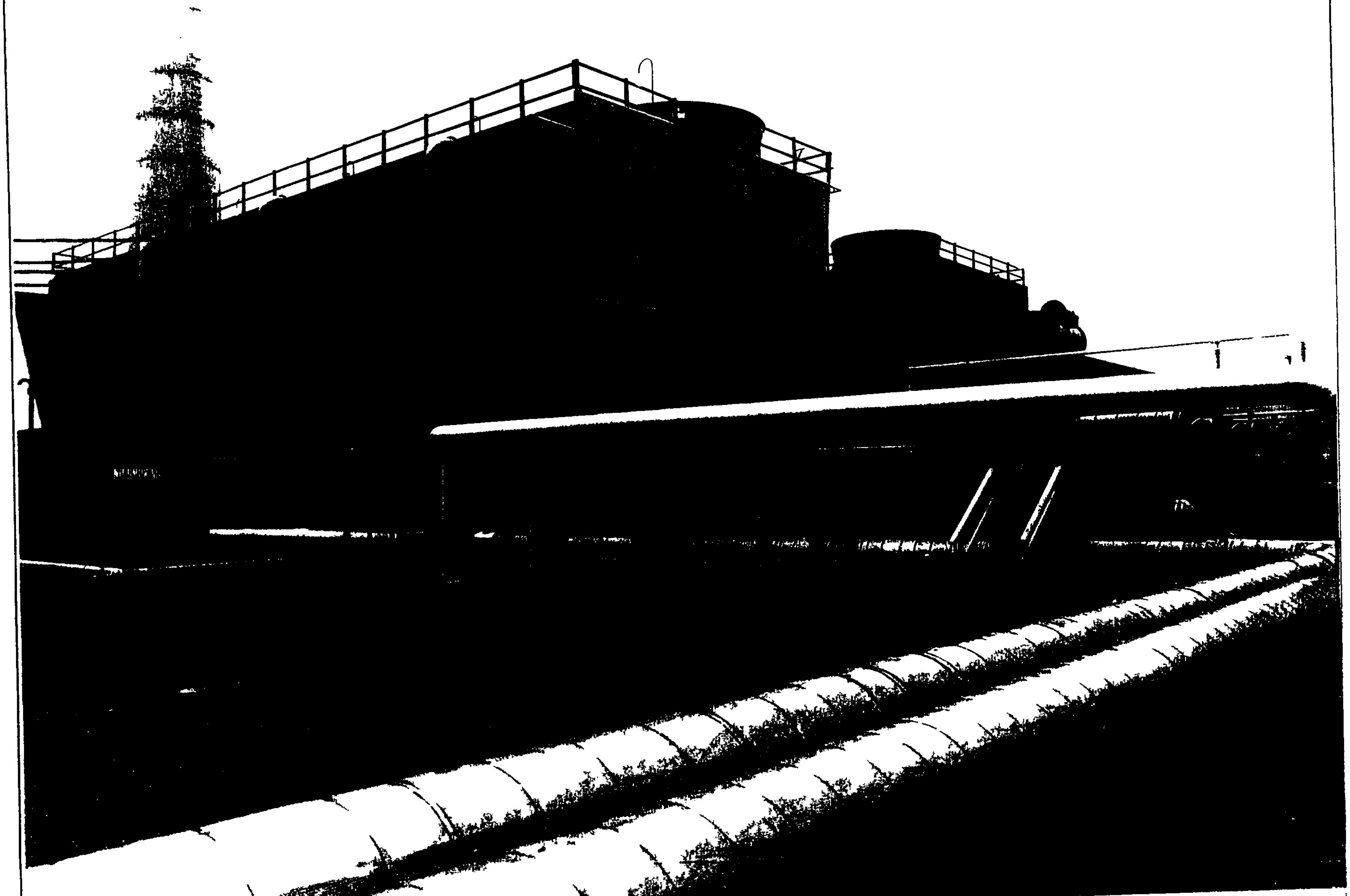
FIGURE 16
OPERABLE UNIT 8
TECHNICAL MEMORANDUM 1

Buildings 881 and 887
Foundation Drains Building Sumps and Outfalls

EG&G ROCKY FLATS

Rocky Flats Plant
P O Box 464
Golden Colorado 80402-0464

76 of 241



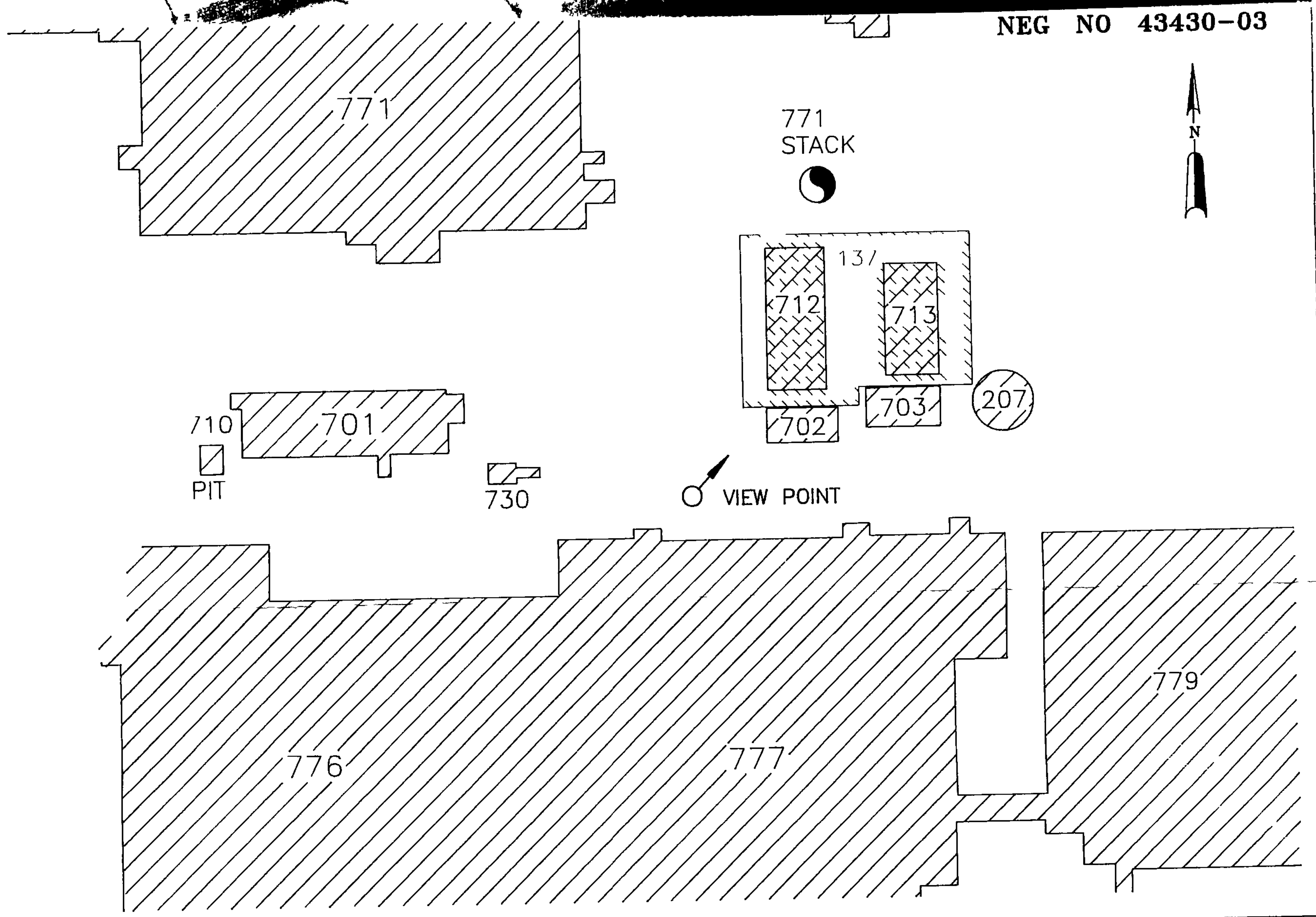


FIGURE 2-7
IHSS 137

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

245/266

NEG NO 43430-06

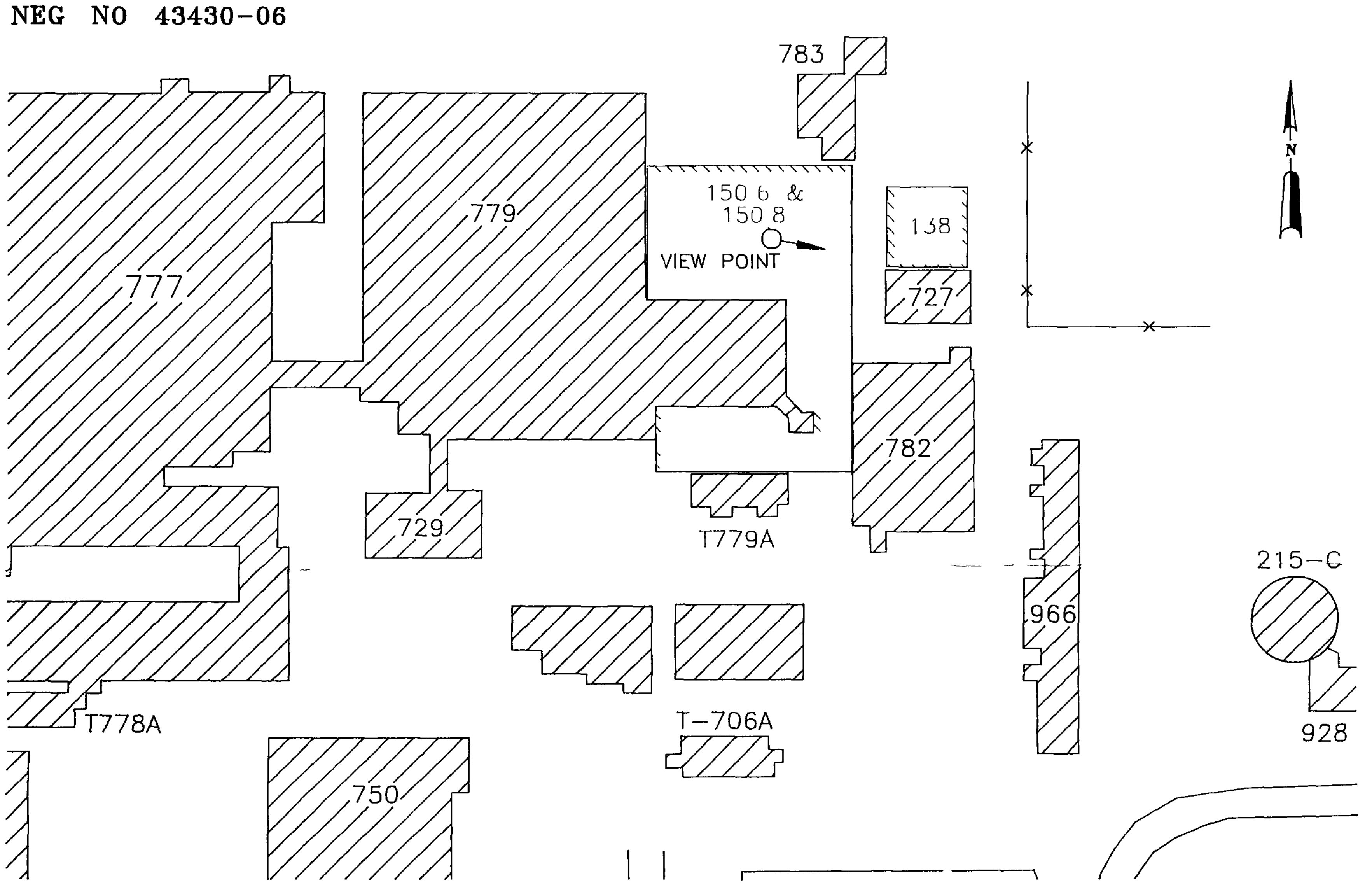


FIGURE 2-8

IHSSs 138 and 150 6/150 8 (partial)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

246/266

NEG NO 43429-01

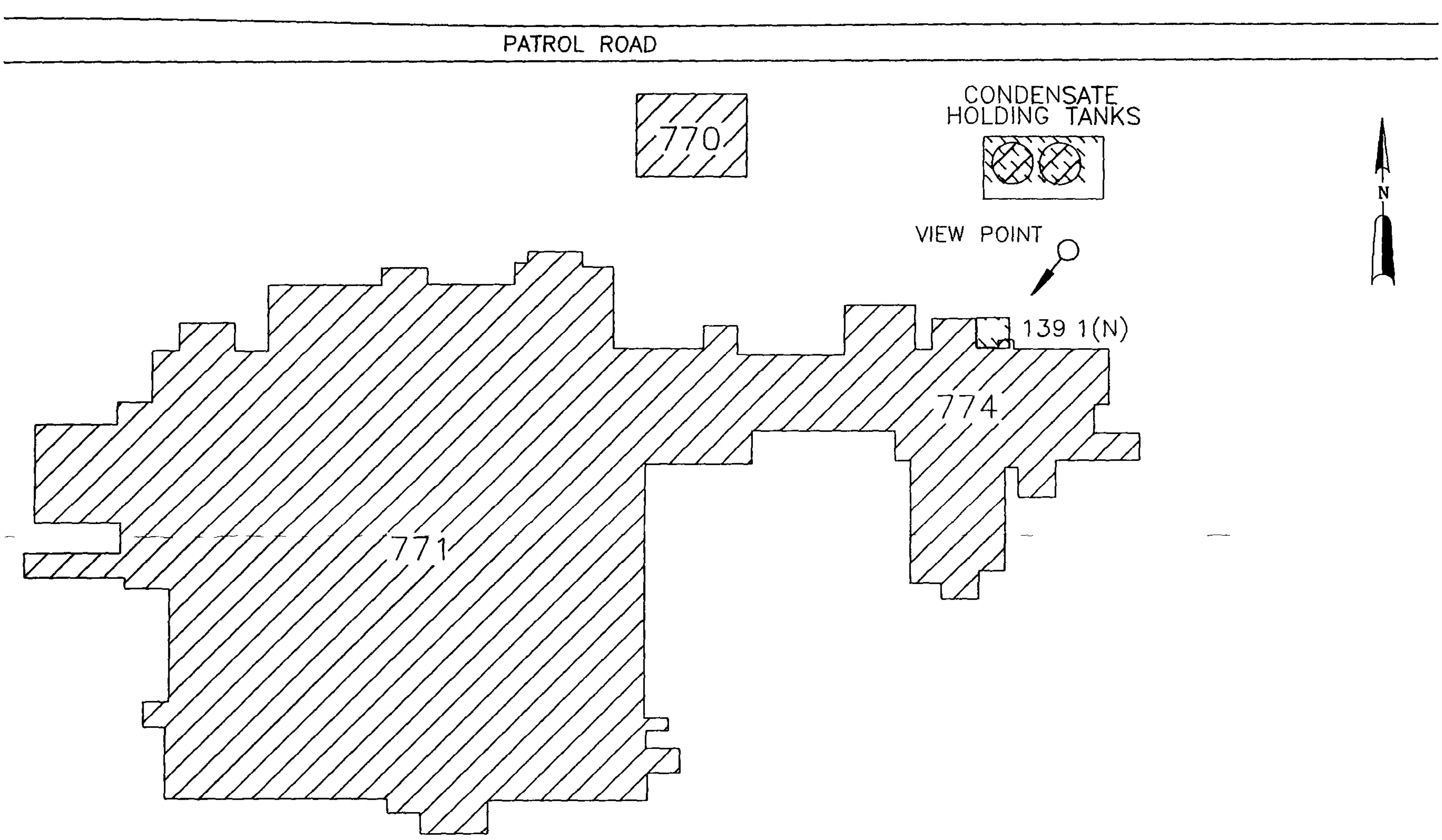
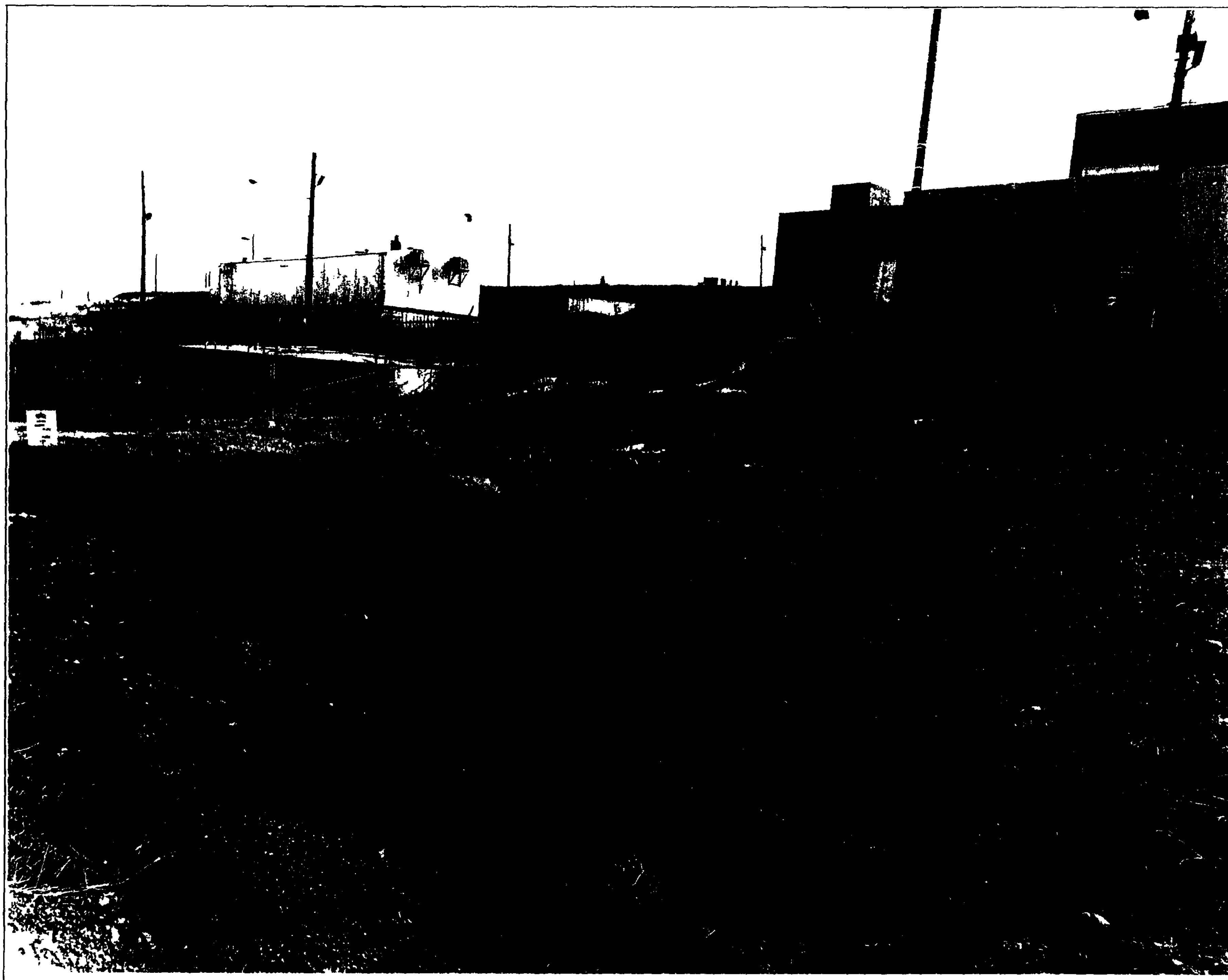


FIGURE 2-9
IHSS 139 1(N)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

247/266



NEG NO 42769-11

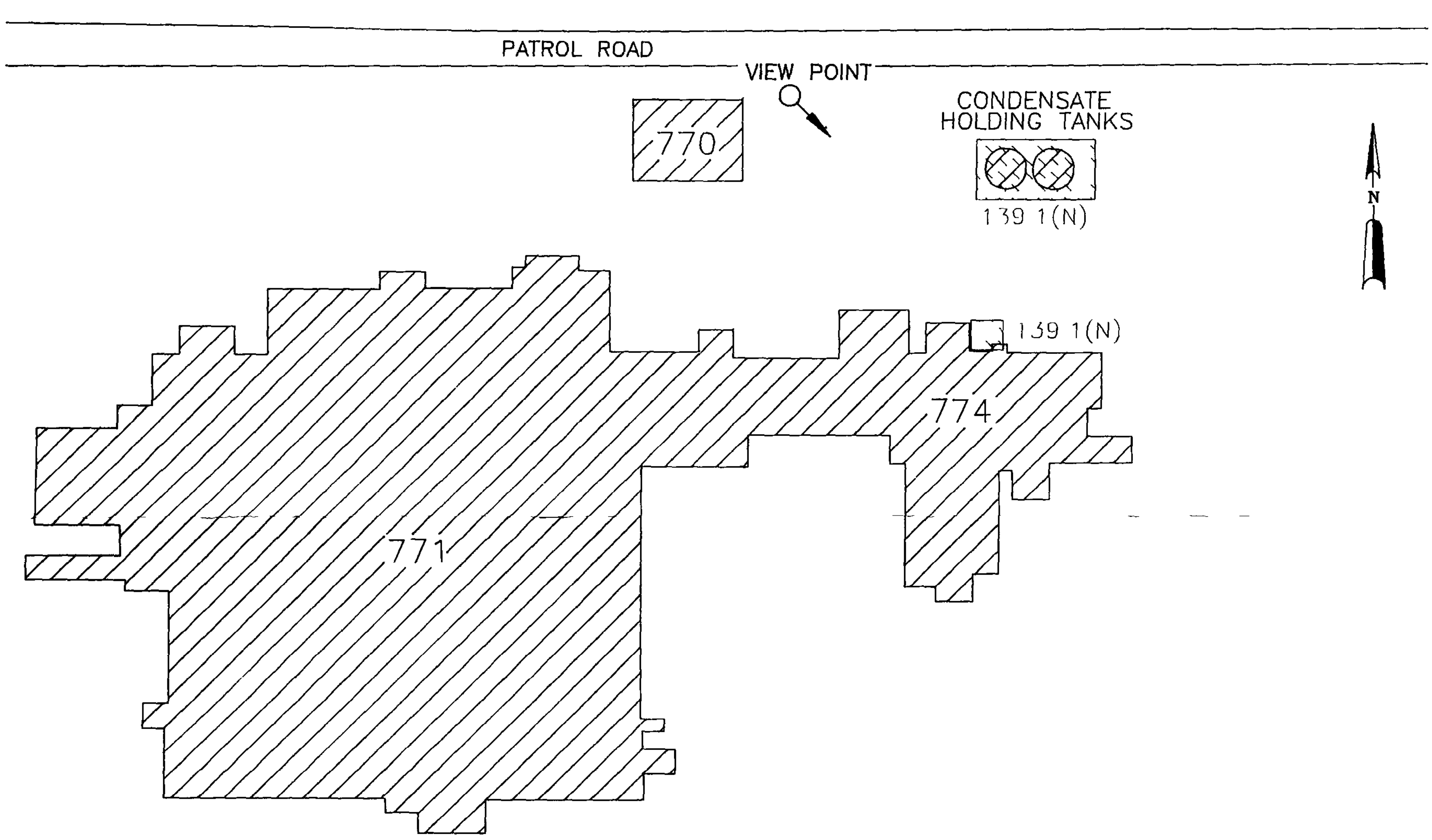


FIGURE 2-10
IHSS 139 1(N)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

248/266

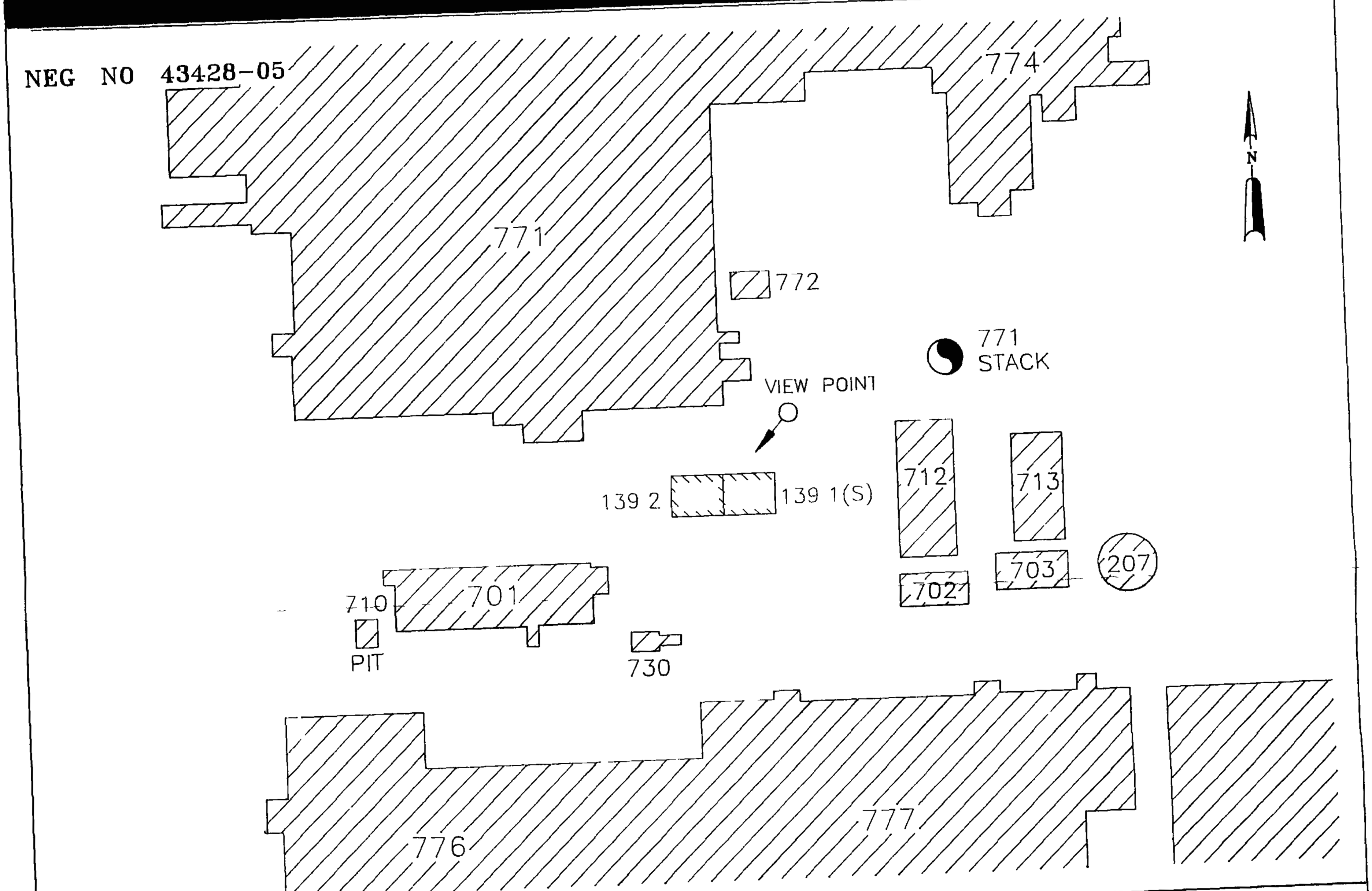


FIGURE 2-11
IHSSs 139 1(S) and 139 2

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

249/266

NEG NO 43428-04

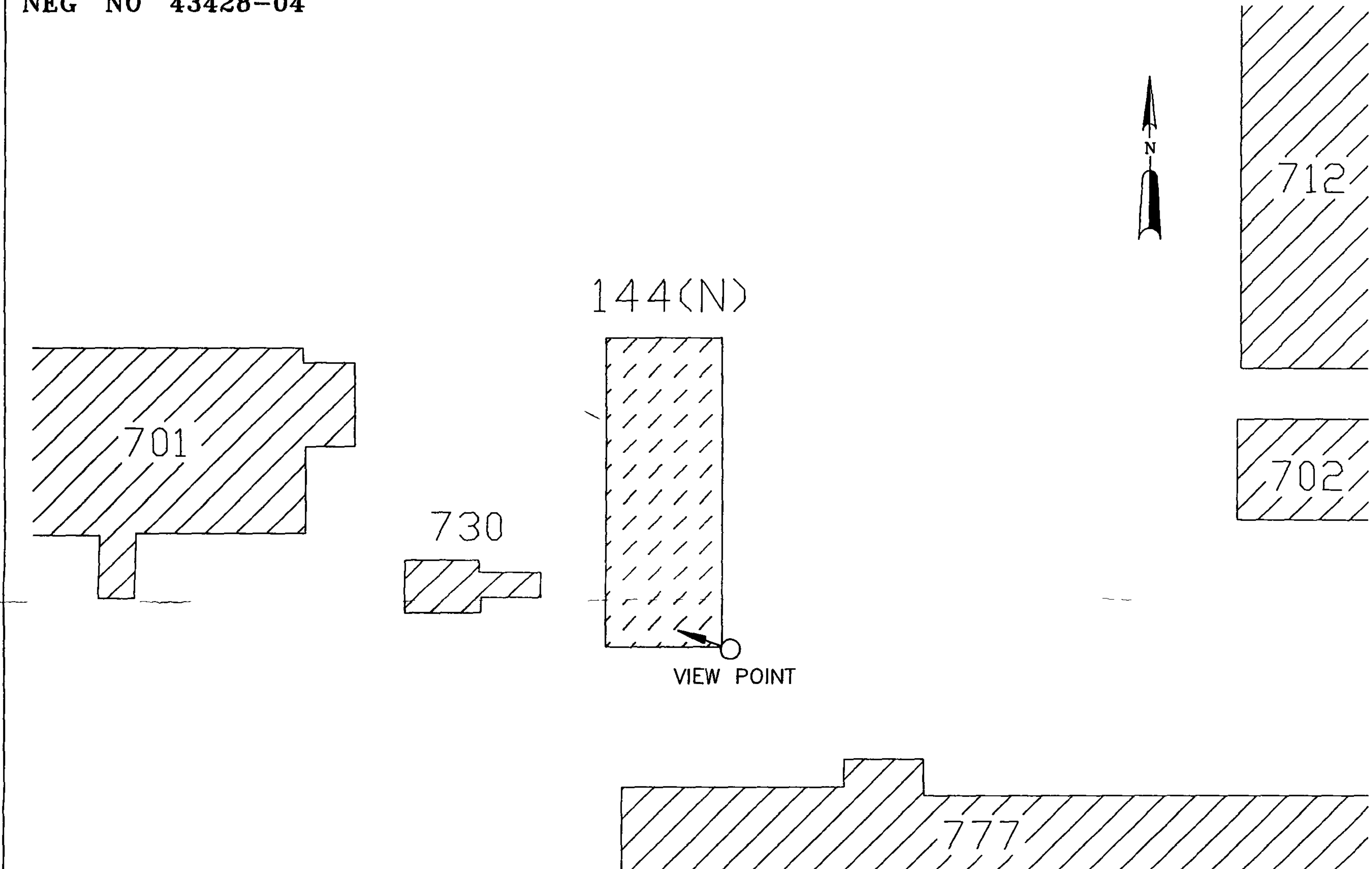


FIGURE 2-12
IHSSs 144(N)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

250/266

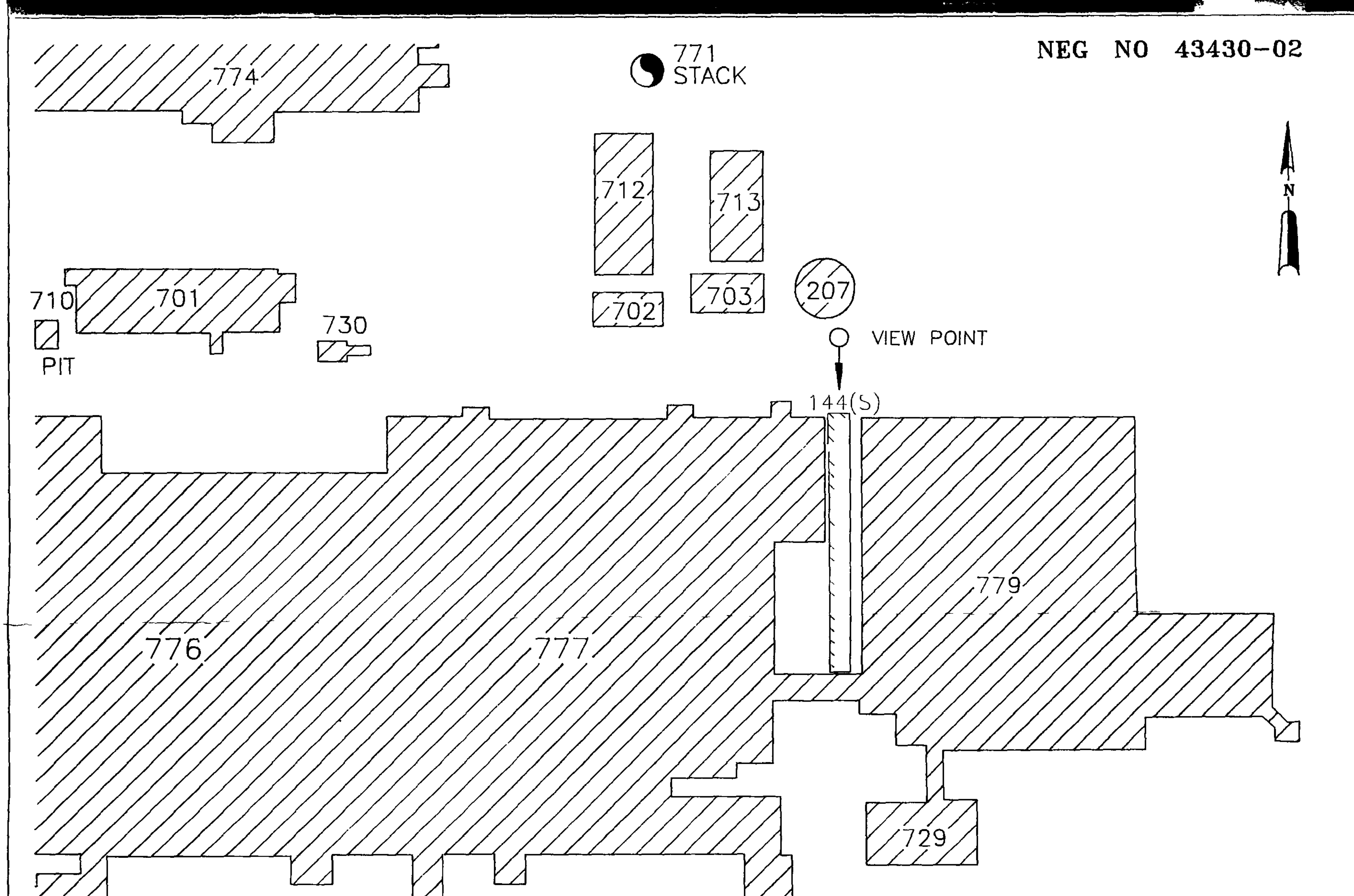
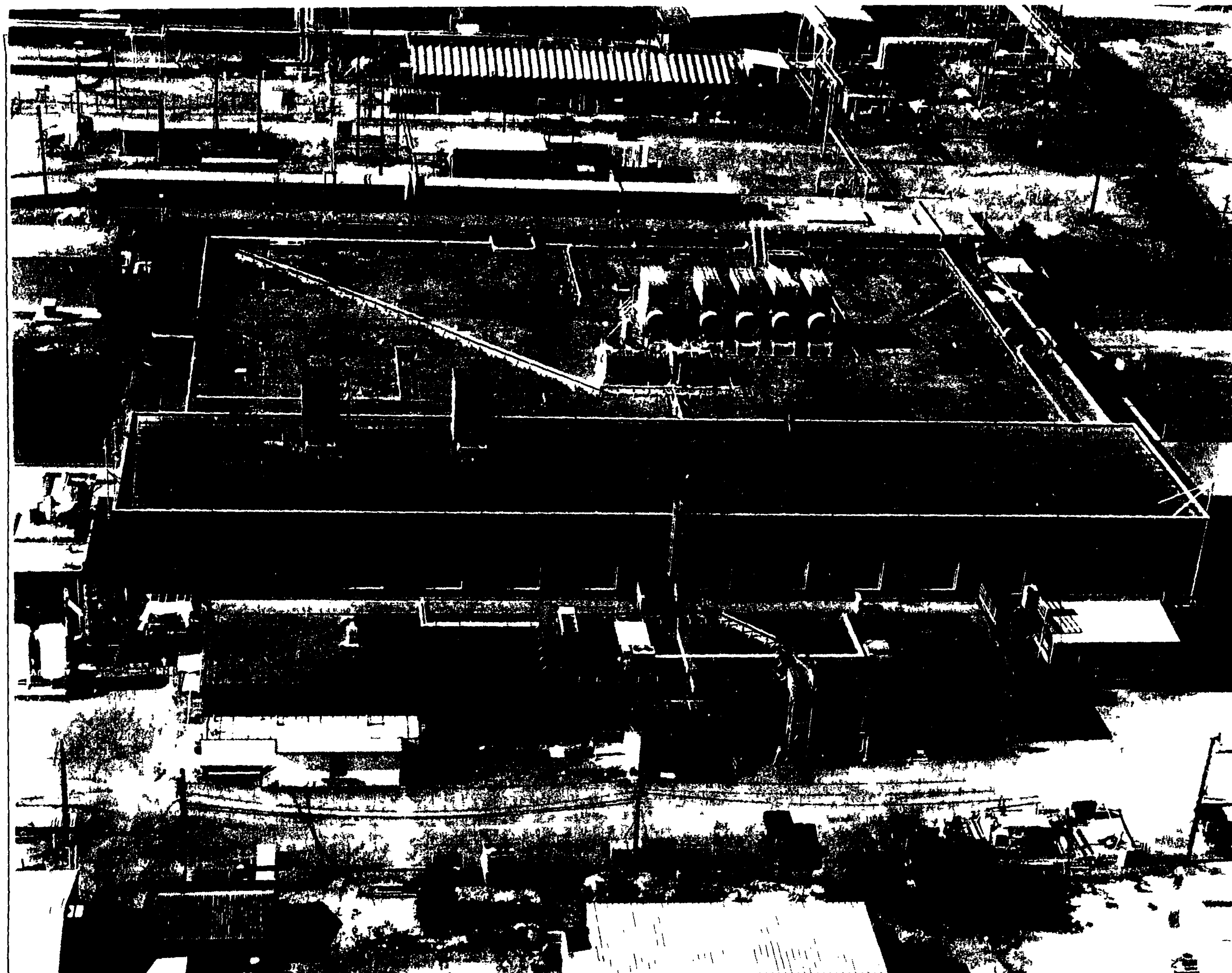


FIGURE 2-13
IHSS 144(S)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

251/266



NEG NO 42089-06

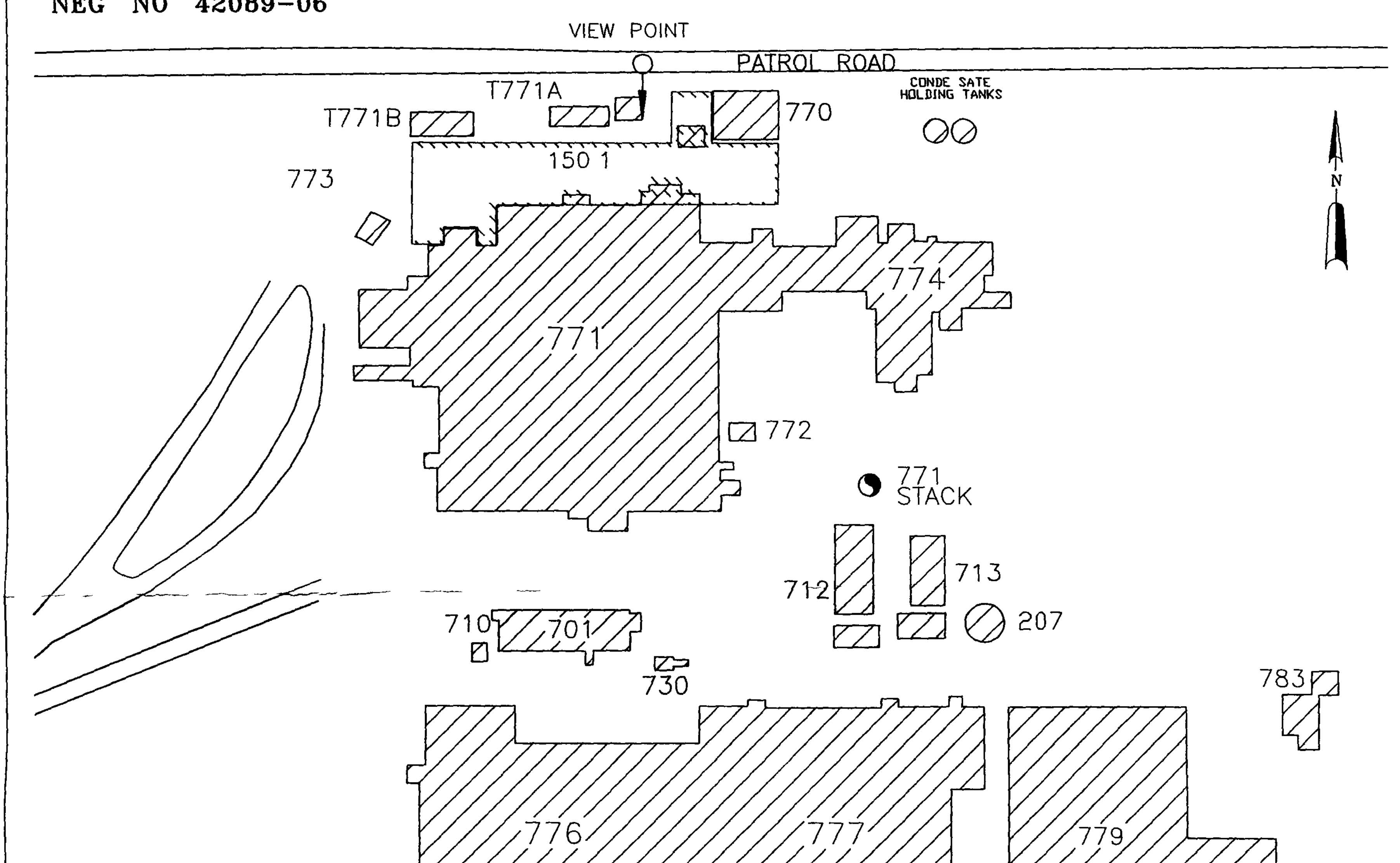


FIGURE 2-14
IHSS 150 1

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

252/266

NEG NO 43427-08

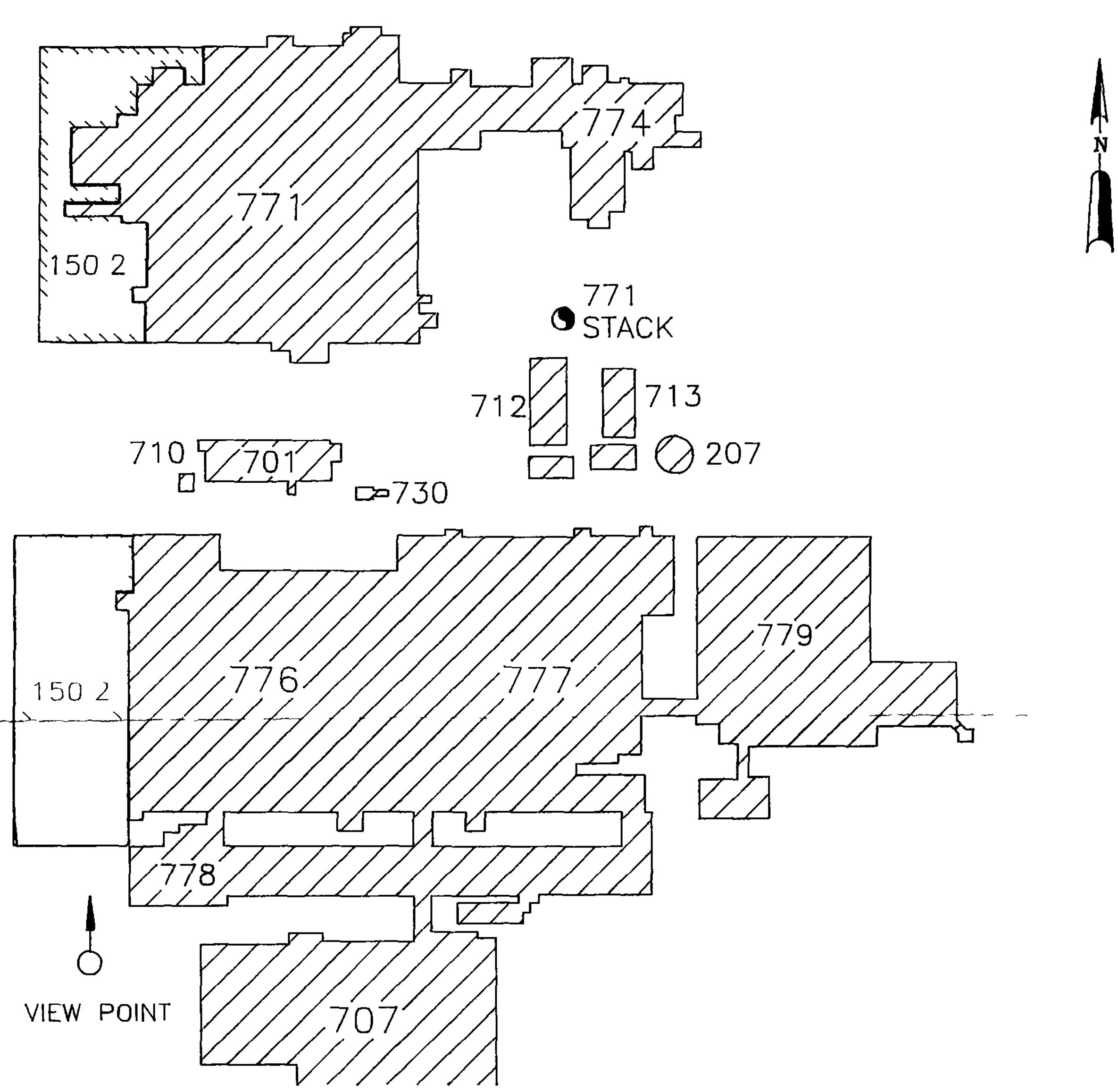


FIGURE 2-15

IHSS 150 2

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

253/266

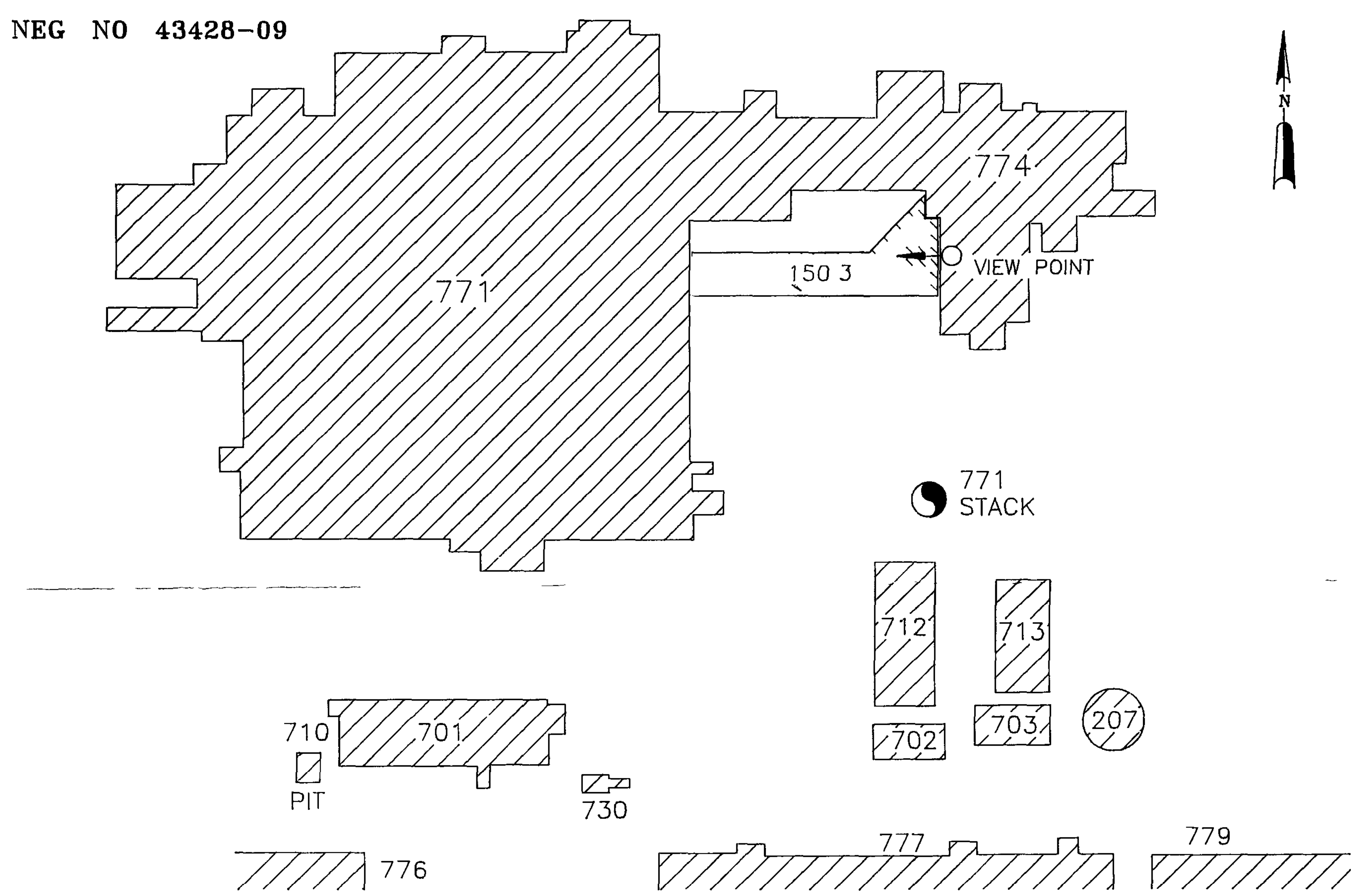


FIGURE 2-16
IHSS 150 3

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

254/266

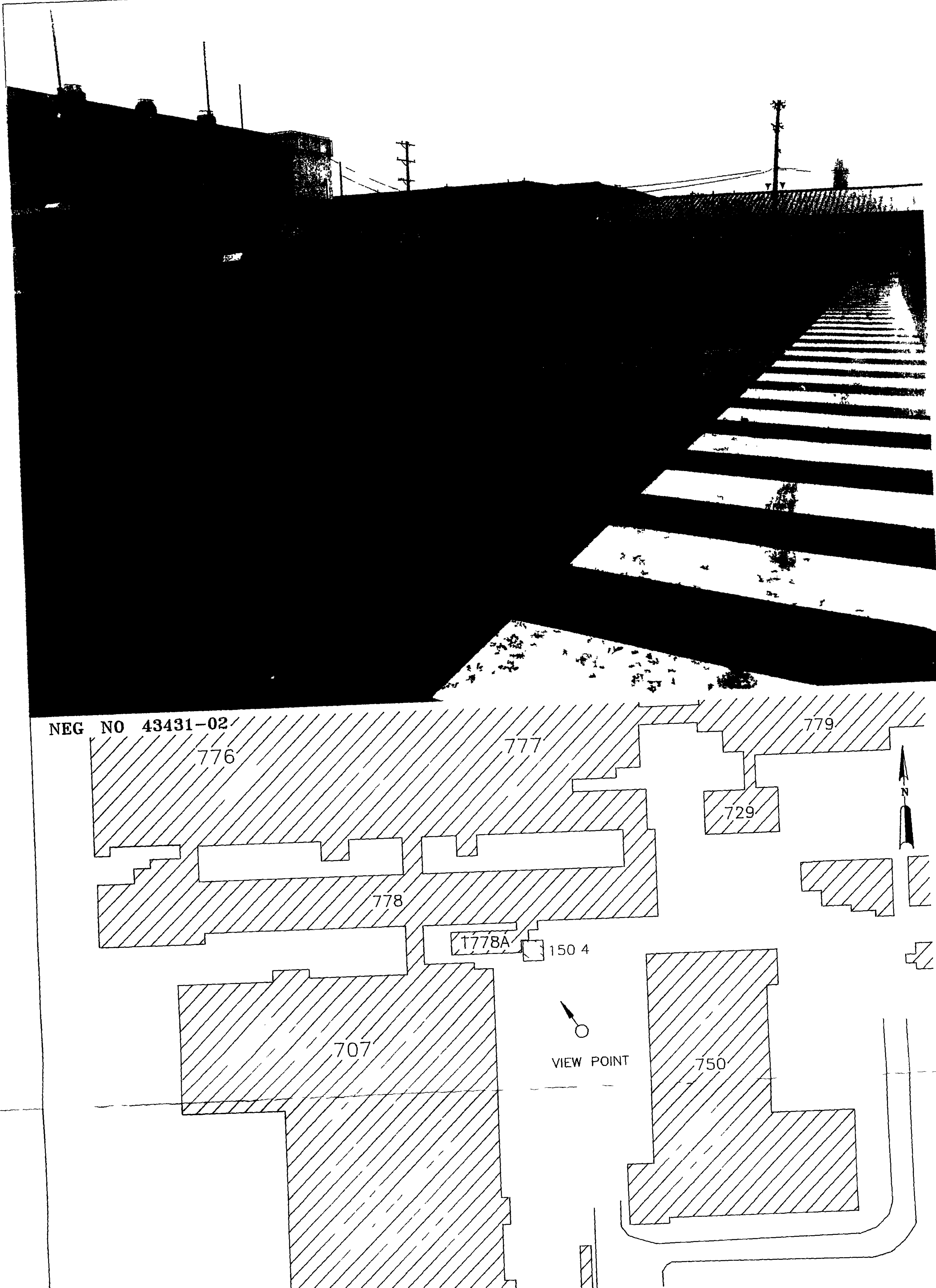


FIGURE 2-17
IHSS 150 4

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

255/266

NEG NO 43430-10

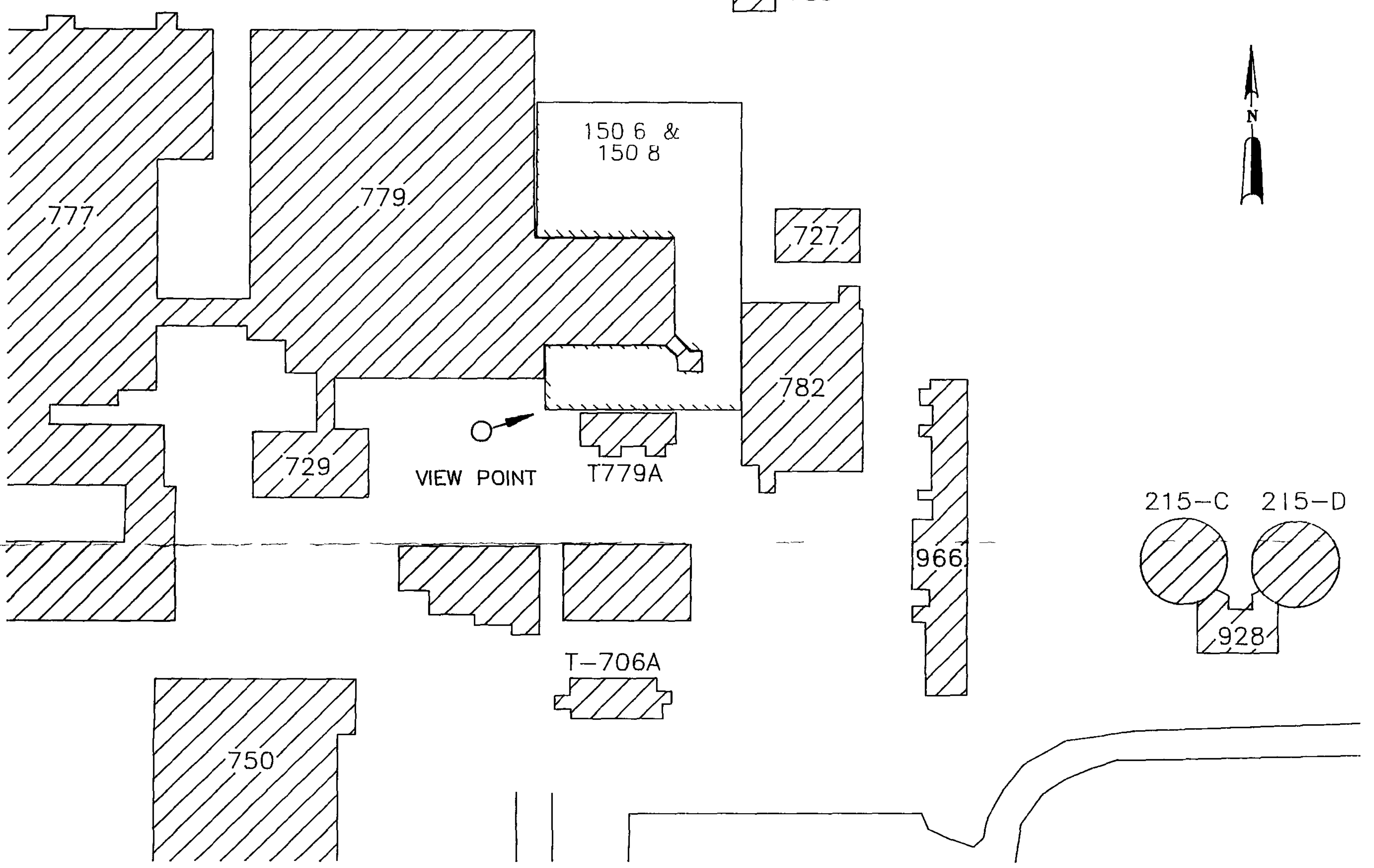


FIGURE 2-18

IHSS 150 6 (partial)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

256/260

NEG NO 43968-01

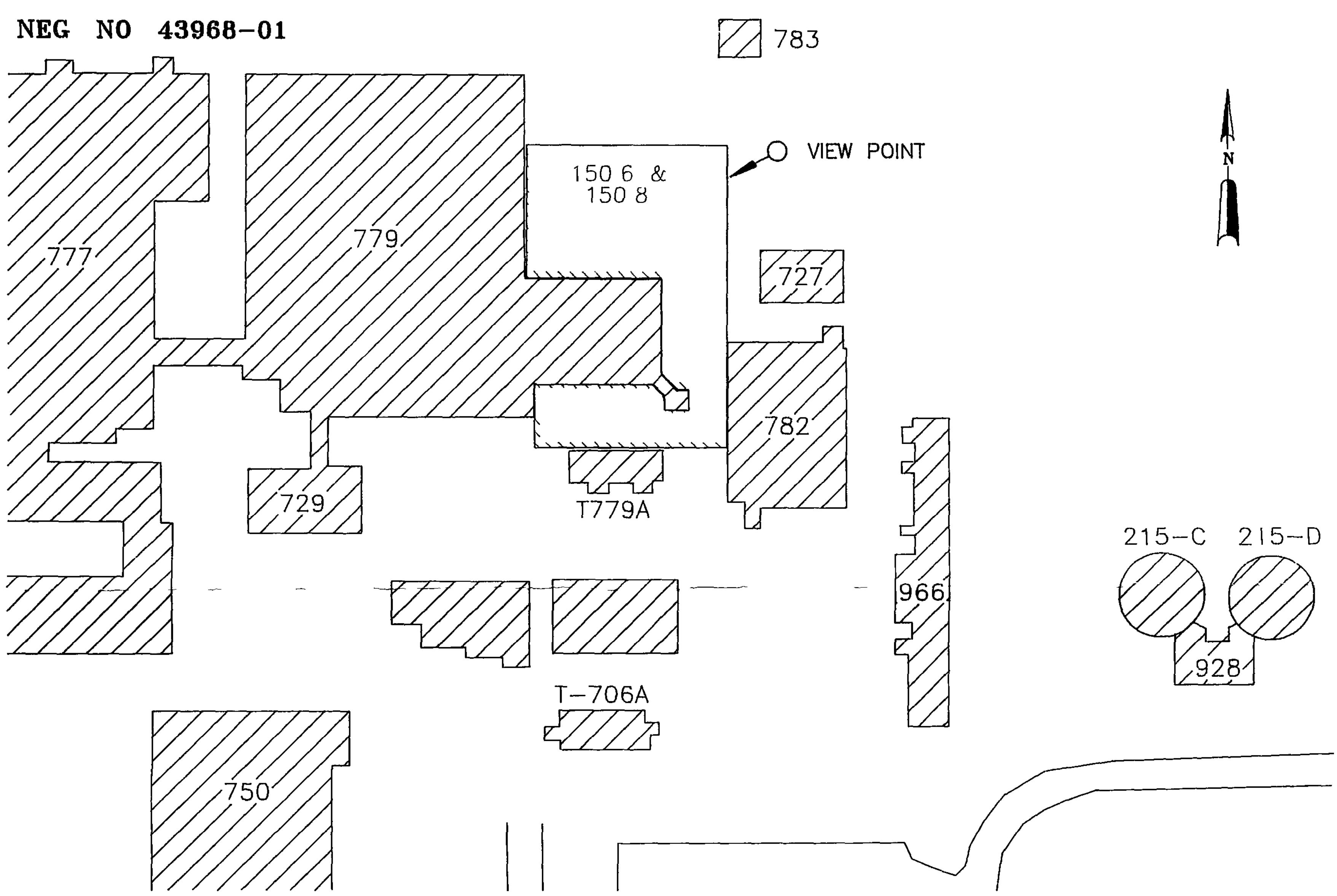


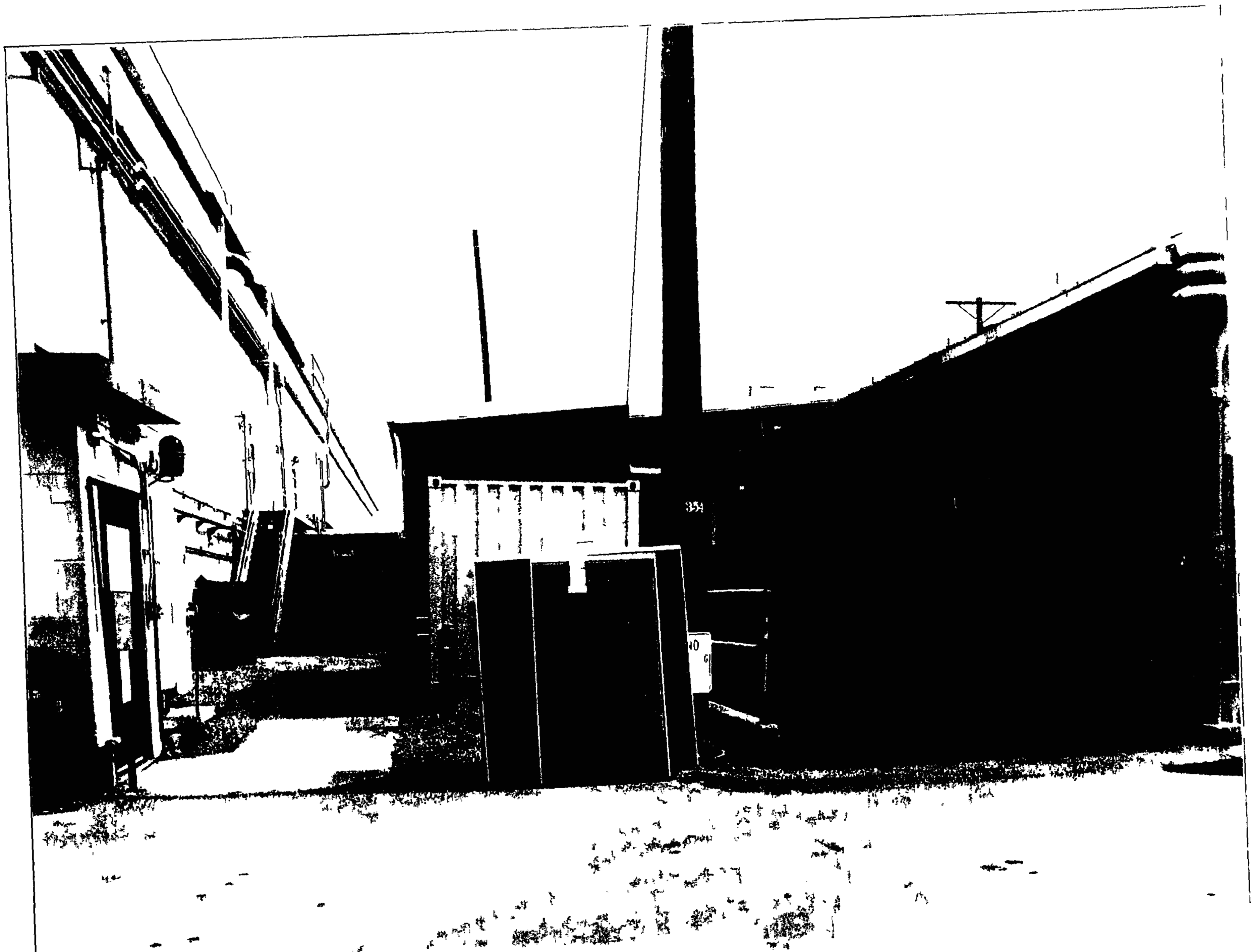
FIGURE 2-19

IHSSs 150 6 and 150 8

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

257/266



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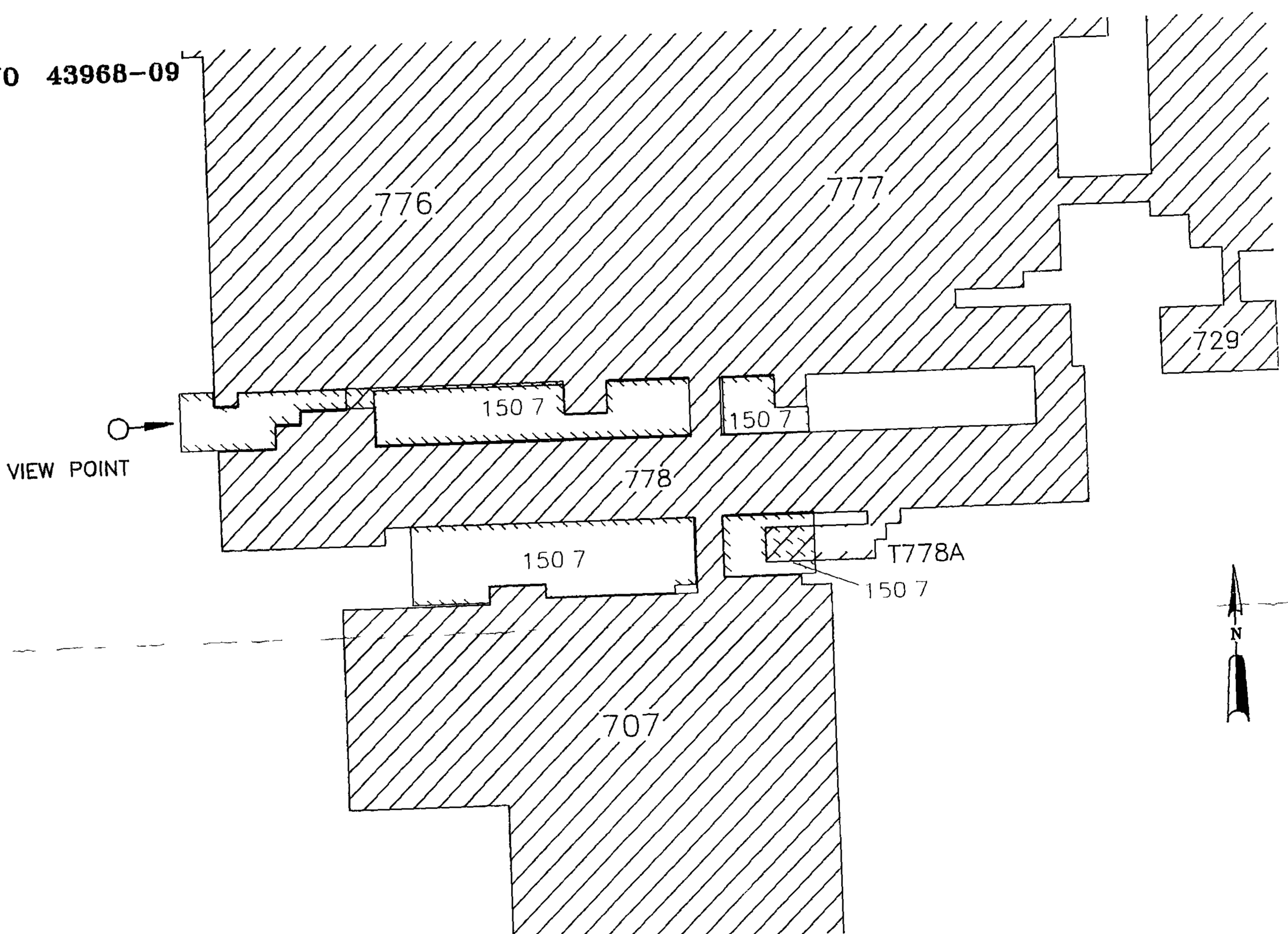


FIGURE 2-20

IHSS 150 7 (partial)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

258/266

NEG NO 43969-04

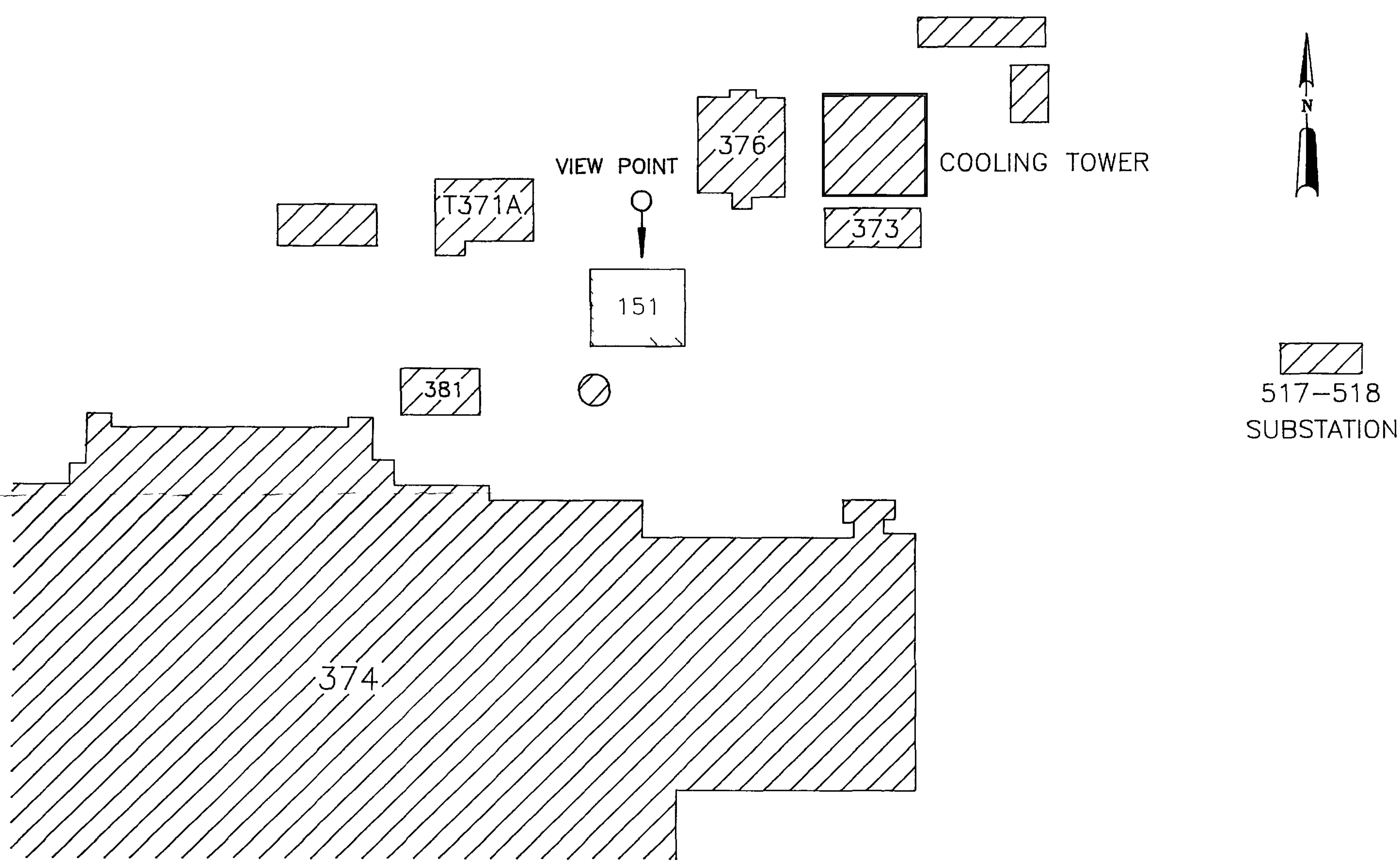


FIGURE 2-21

IHSS 151

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

259/266

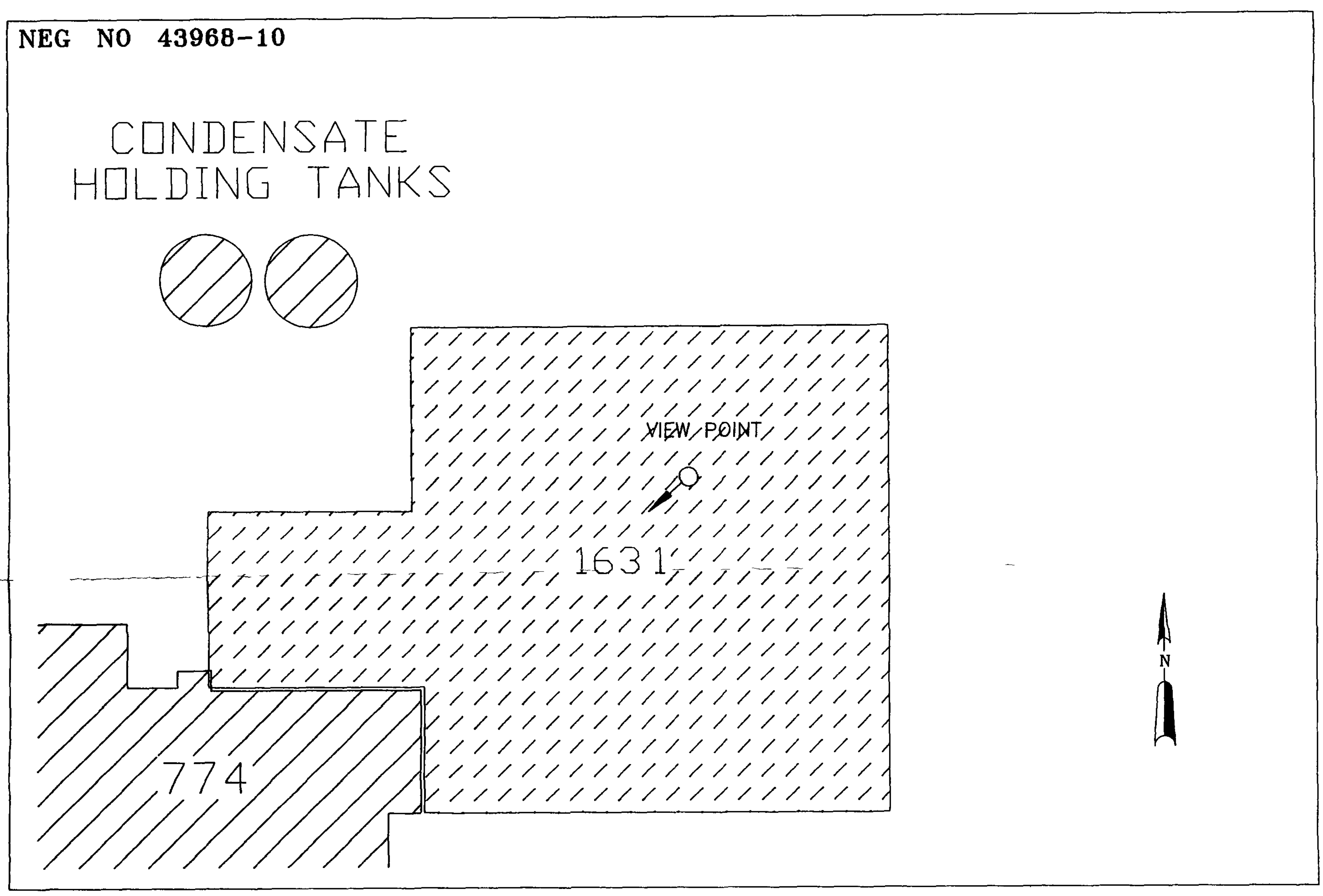


FIGURE 2-22
IHSSs 163 1

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

260/266

NEG NO 43429-04

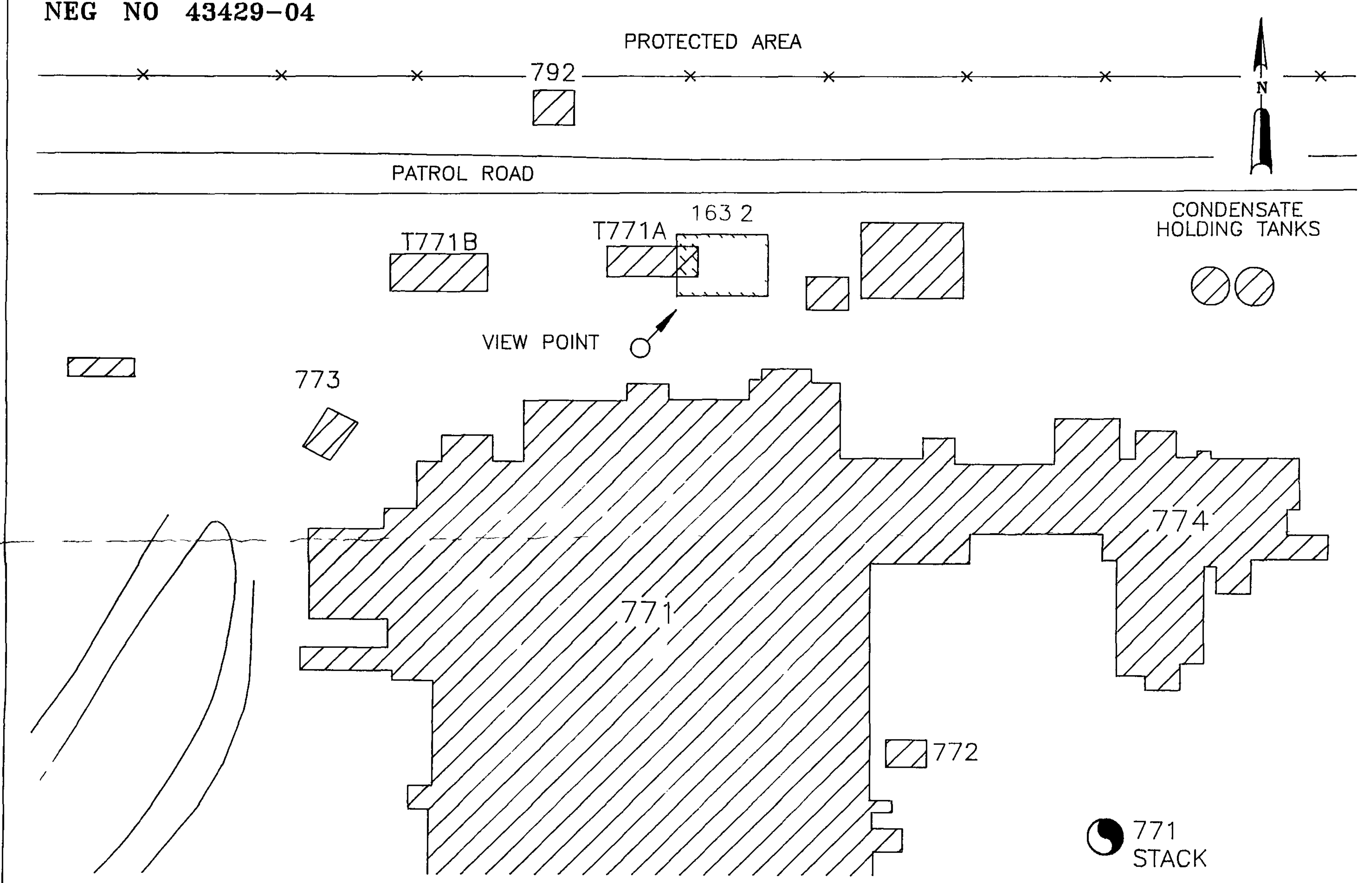


FIGURE 2-23

IHSS 163 2

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

261/266

NEG NO 42090-00

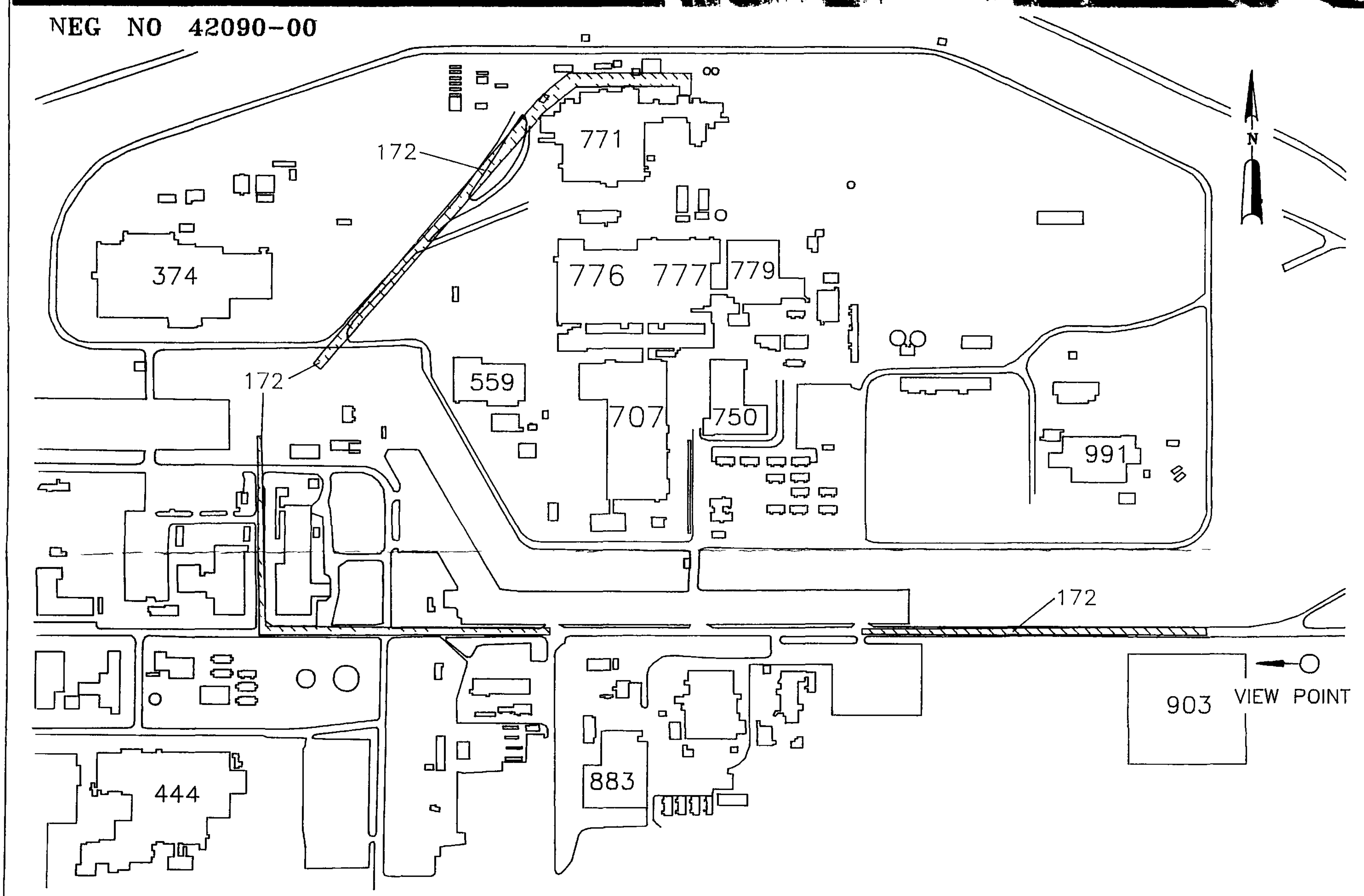


FIGURE 2-24

IHSS 172

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

262/26

367

NEG NO 43431-06

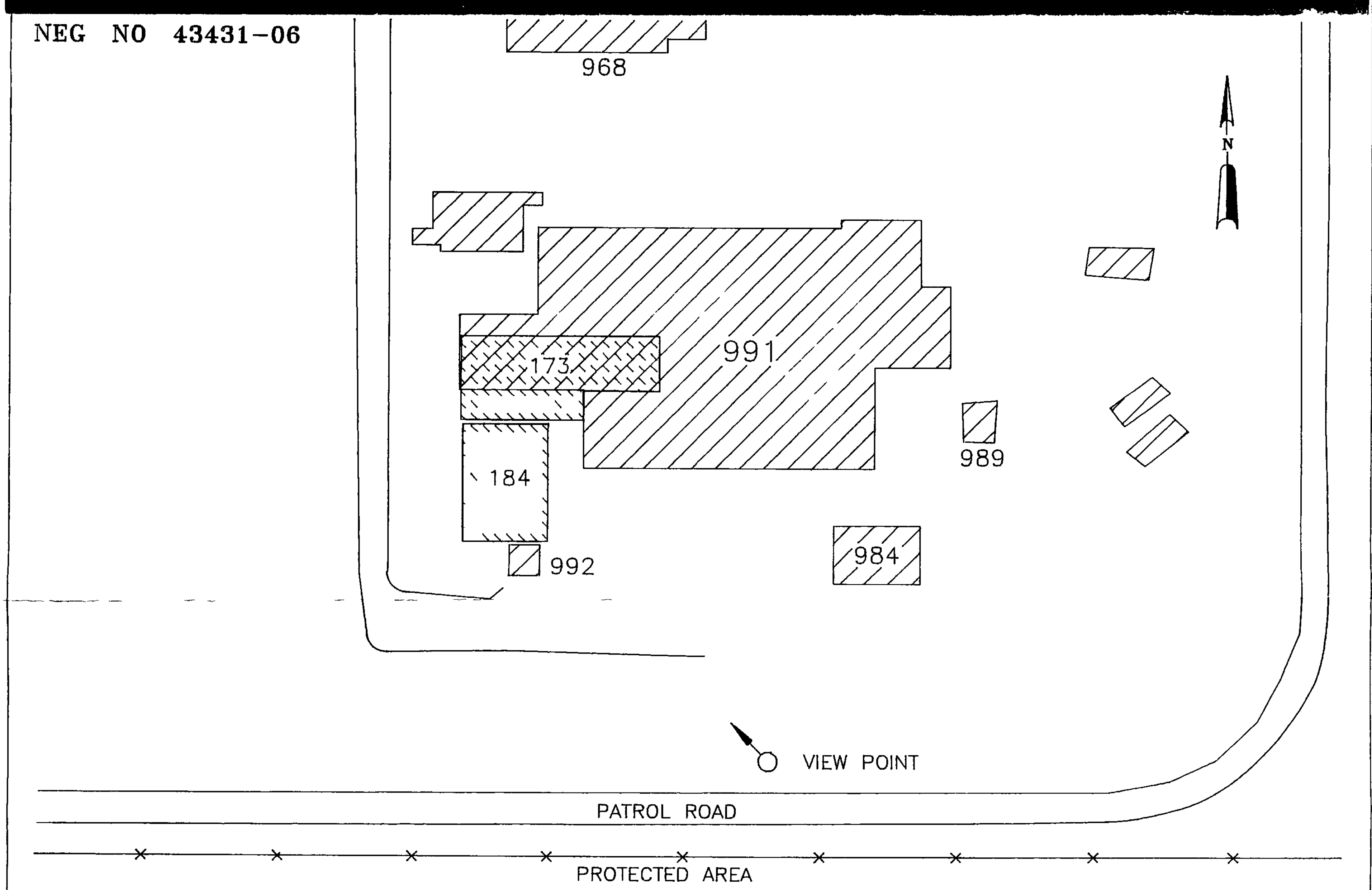


FIGURE 2-25

IHSSs 173 and 184

OPFRABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

263/266

368

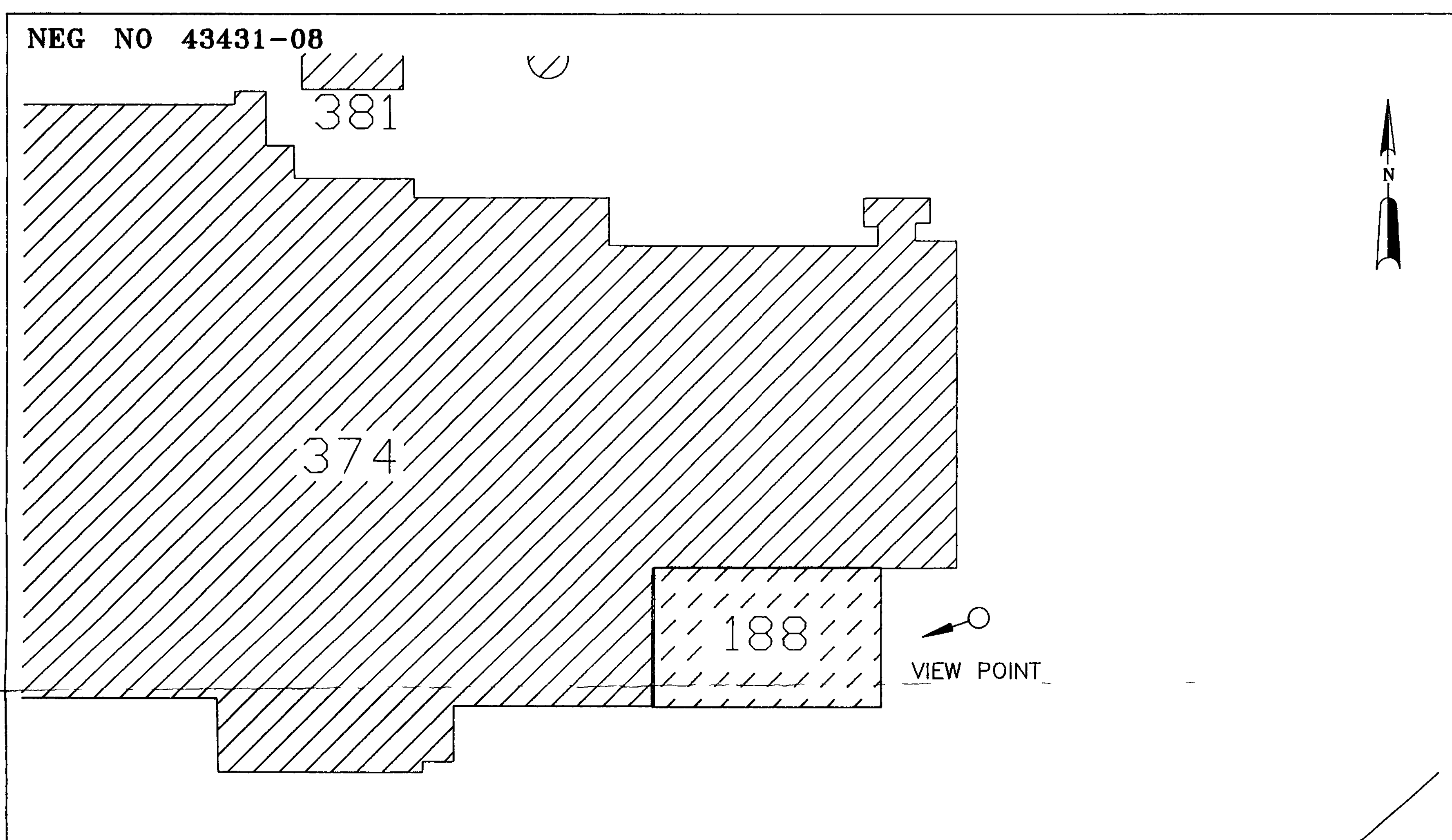


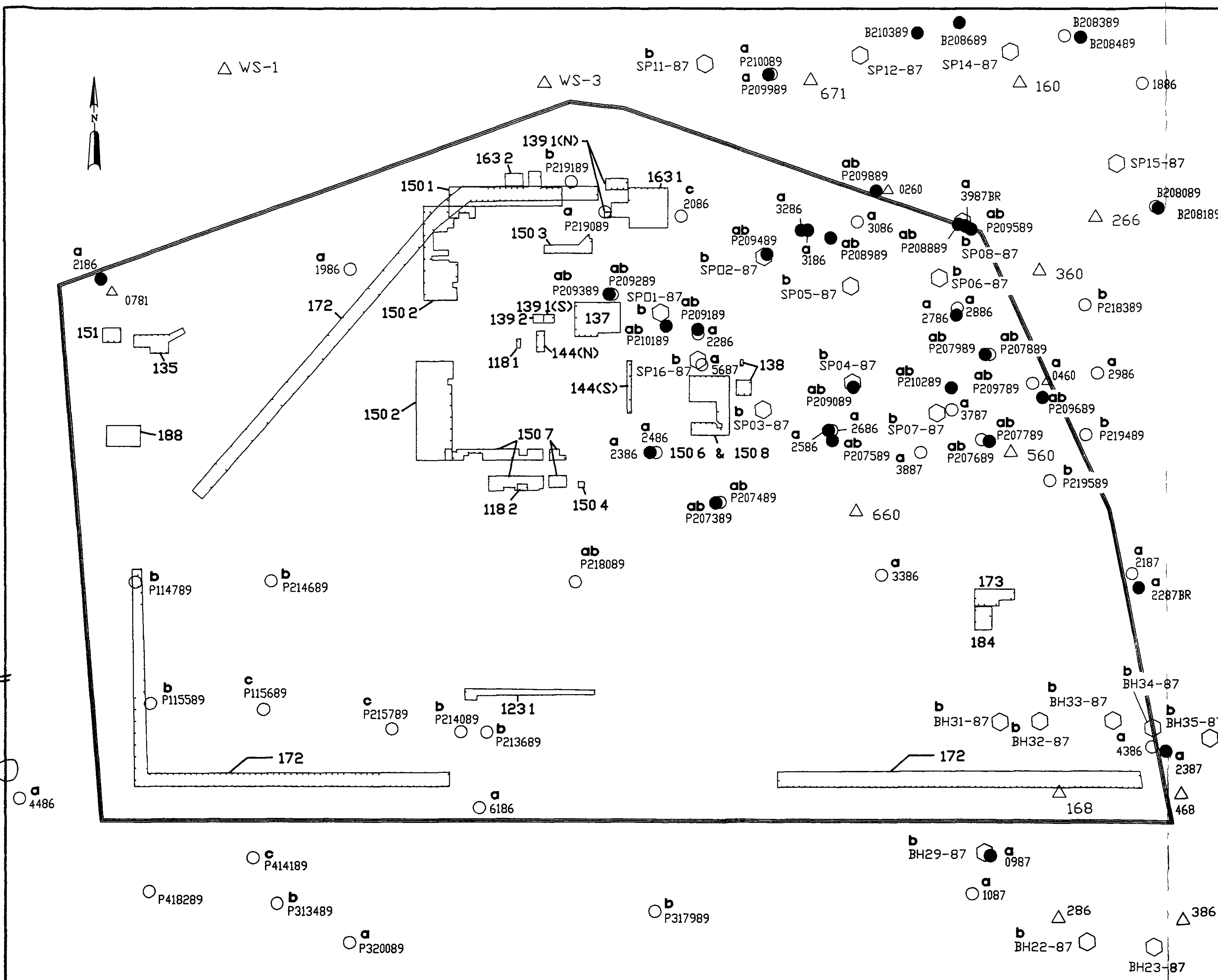
FIGURE 2-26
IHSSs 188

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

264/266

265/266



File Name OU82-27 DWG

MAP LEGEND

OU8 BOUNDARY

137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND NUMBERS

a GROUNDWATER CHEMISTRY DATA

b BOREHOLE SAMPLE CHEMISTRY DATA

c NO DATA AVAILABLE

NOTE THE ABSENCE OF ONE OF THE ABOVE IDENTIFIERS SIGNIFIES THAT NO DATA WAS REQUESTED FOR THIS WELL

P207589 ● BEDROCK WELL

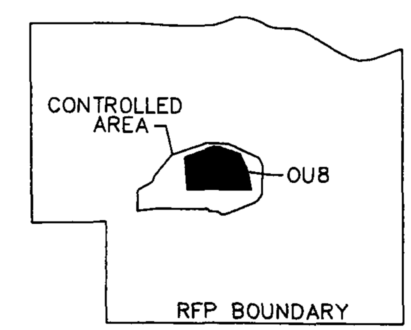
P219589 ○ ALLUVIAL WELL

BH33-87 ⬡ BOREHOLE

560 △ ABANDONED WELL

SCALE IN FEET

0 300 600



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

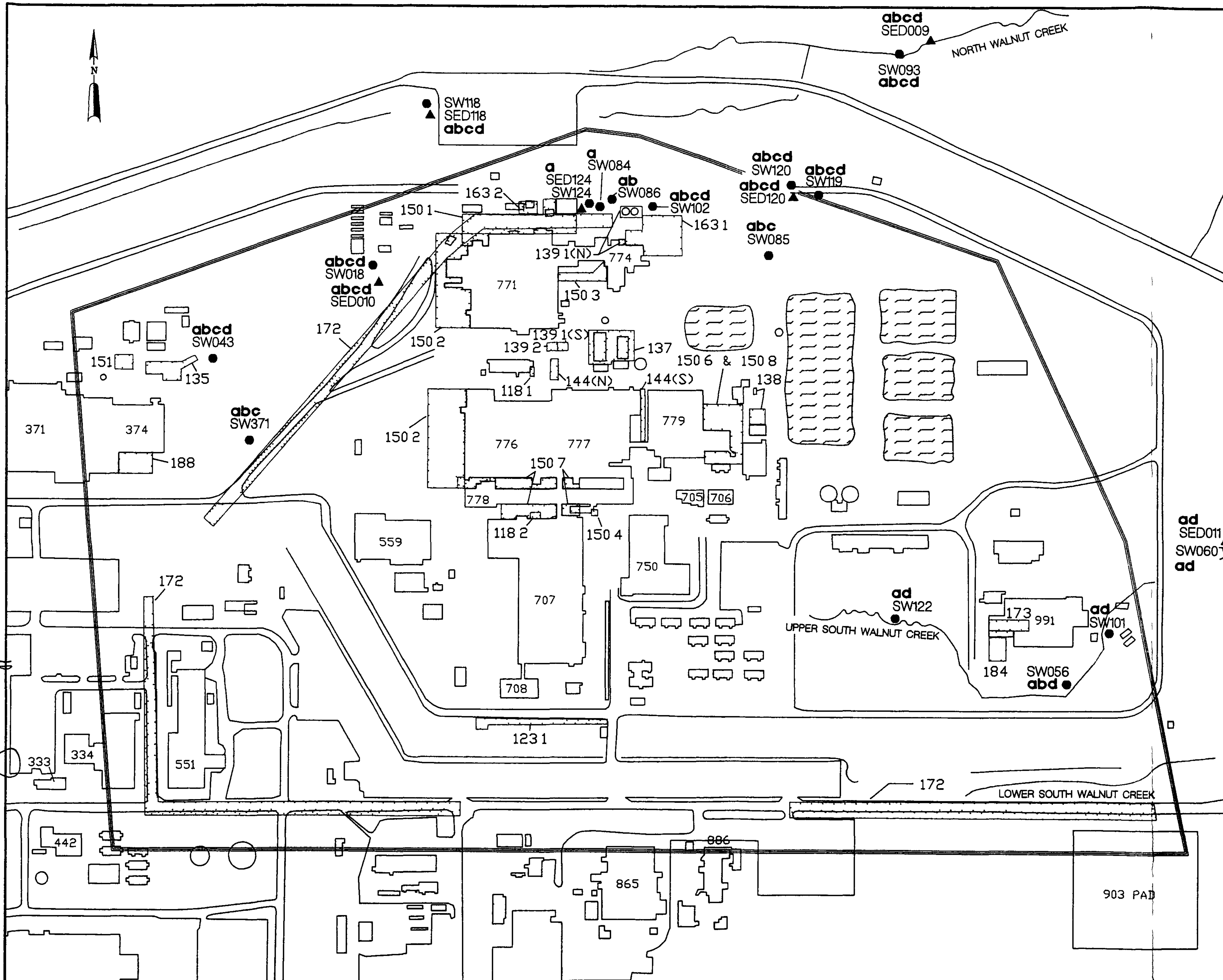
FIGURE 2 27

TYPES OF ANALYTICAL DATA AVAILABLE FOR WELLS PIEZOMETERS AND BOREHOLES

Approved By [signature] Date 11 /23/92

369

266/266



File Name OU82-32 DWG

MAP LEGEND

ROADWAYS

SURFACE WATER FEATURES

991 BUILDINGS AND NUMBERS

137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND NUMBERS

EXISTING SAMPLING LOCATION

SW121 ● SURFACE WATER SAMPLING

SED124 ▲ SURFACE WATER SEDIMENT

a RADIONUCLIDE DATA

b TRACE METAL DATA

c INORGANICS DATA

d VOC DATA

SCALE IN FEET

0 300 600

CONTROLLED AREA

OU8

RFP BOUNDARY

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

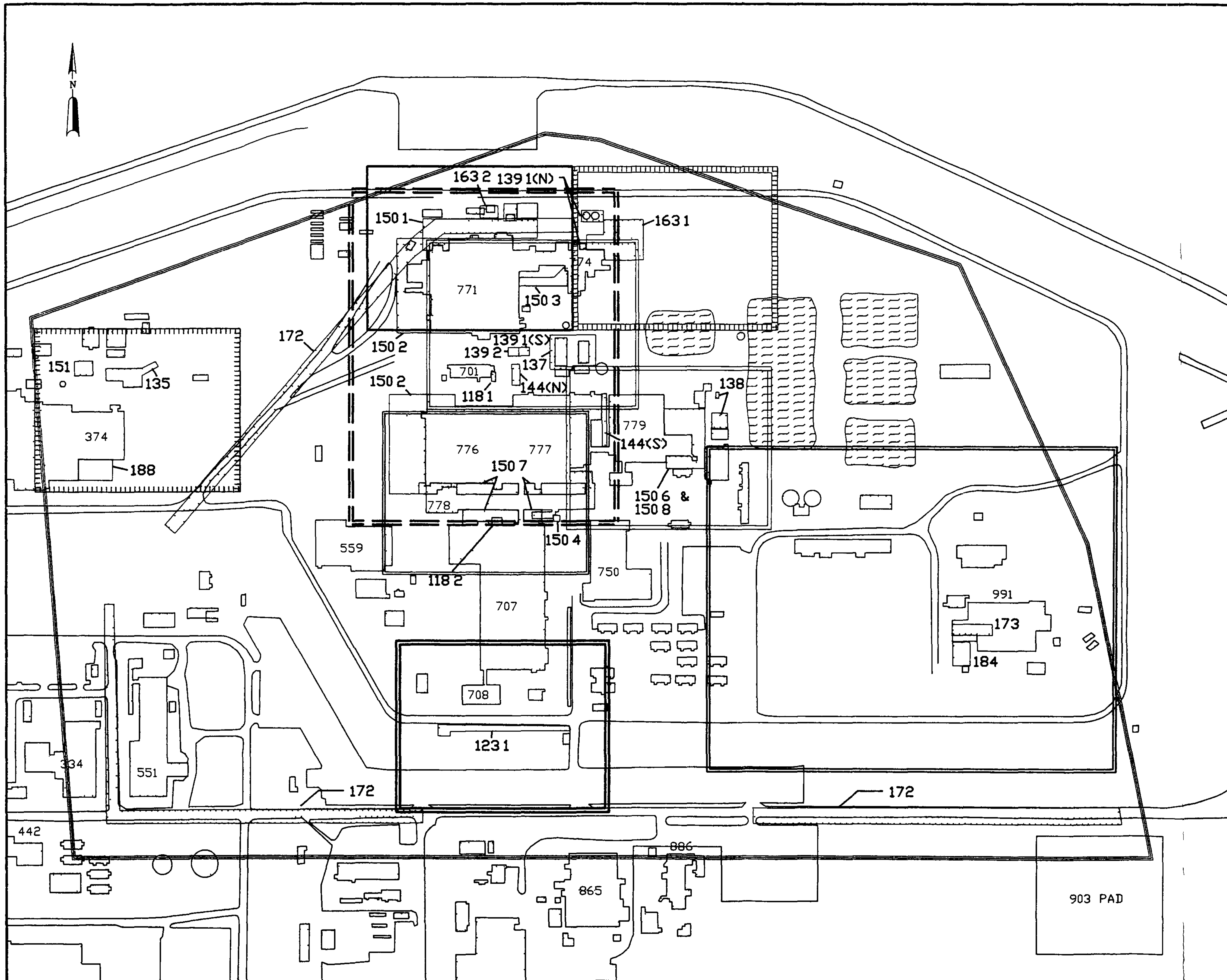
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 2 32

TYPES OF ANALYTICAL DATA AVAILABLE FOR SURFACE WATER AND SEDIMENT MONITORING SITES

Approved By [signature] Date 11/23/92

90/100



File Name OU86-4 DWG

MAP LEGEND

ROADWAYS

991 BUILDINGS AND NUMBERS

137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS) AND NUMBERS

EVAPORATION PONDS

OU8 BOUNDARY

INDEX TO IHSS LOCATION MAPS

FIGURE 6 5

FIGURE 6-6

FIGURE 6 7

FIGURE 6-8

FIGURE 6 9

FIGURE 6 10

FIGURE 6 11

FIGURE 6 12

FIGURE 6 13

SCALE IN FEET

0 300 600

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

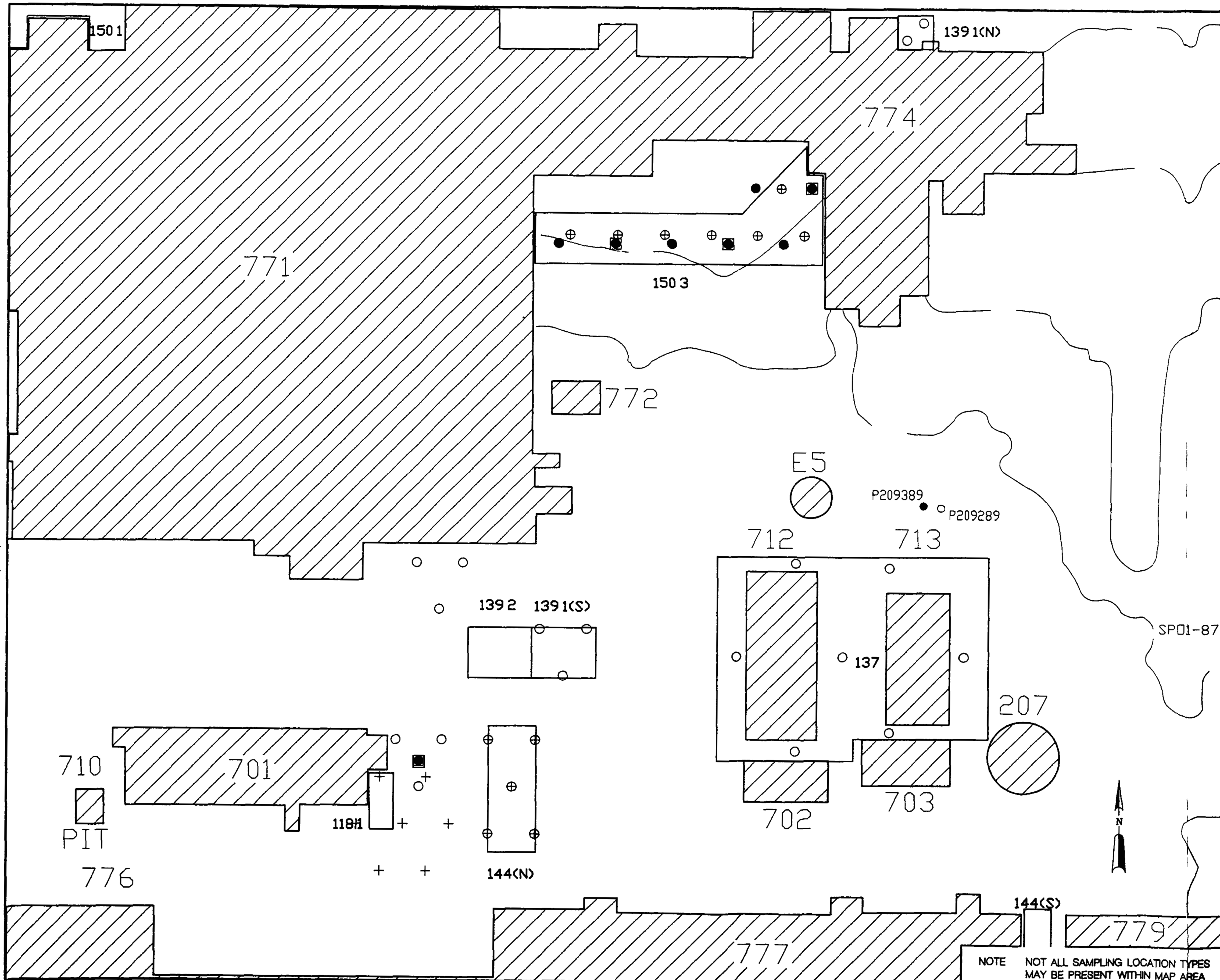
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 4

INDEX MAP TO FIGURES 6 3 TO 6 13

Appro d By PJJ Dat 11/23/92

91/100



File Name OU86-5 DWG

MAP LEGEND

ROADWAYS

SURFACE WATER FEATURES

BUILDINGS AND NUMBERS

137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND NUMBERS

EXISTING SAMPLING LOCATION

SW121 ○ SURFACE WATER SAMPLING

SED124 ○ SURFACE WATER SEDIMENT

P207589 ● BEDROCK WELL

P219589 ○ ALLUVIAL WELL

BH33-87 ⬡ BOREHOLE

560 △ PRE 1986 MONITOR WELL

PROPOSED STAGE 2 SAMPLE LOCATIONS

+ SOILGAS

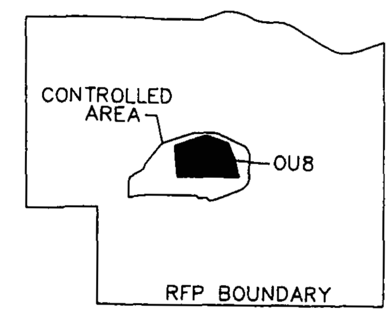
○ SURFICIAL SOIL

● HPGe

□ VERTICAL SOIL PROFILE (ACTUAL LOCATION WILL BE SELECTED IN THE FIELD)

SCALE IN FEET

0 50 100



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

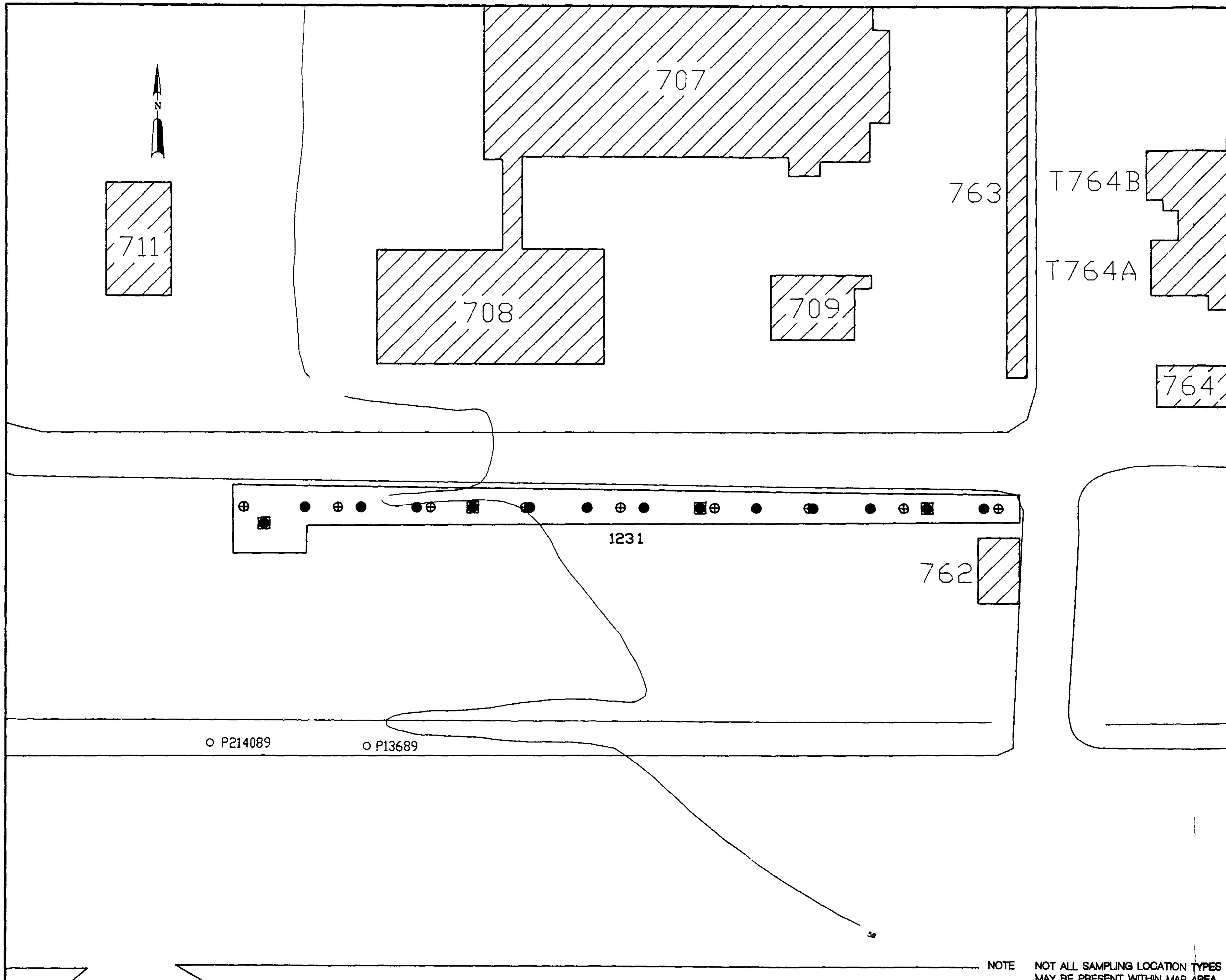
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 5

PROPOSED SAMPLING LOCATIONS
IHSS Nos 118 1 137 139 1(S)
139 2 144(N) & 150 3

App d By PJS Dt 11/23/22

93/100



NOTE NOT ALL SAMPLING LOCATION TYPES MAY BE PRESENT WITHIN MAP AREA

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

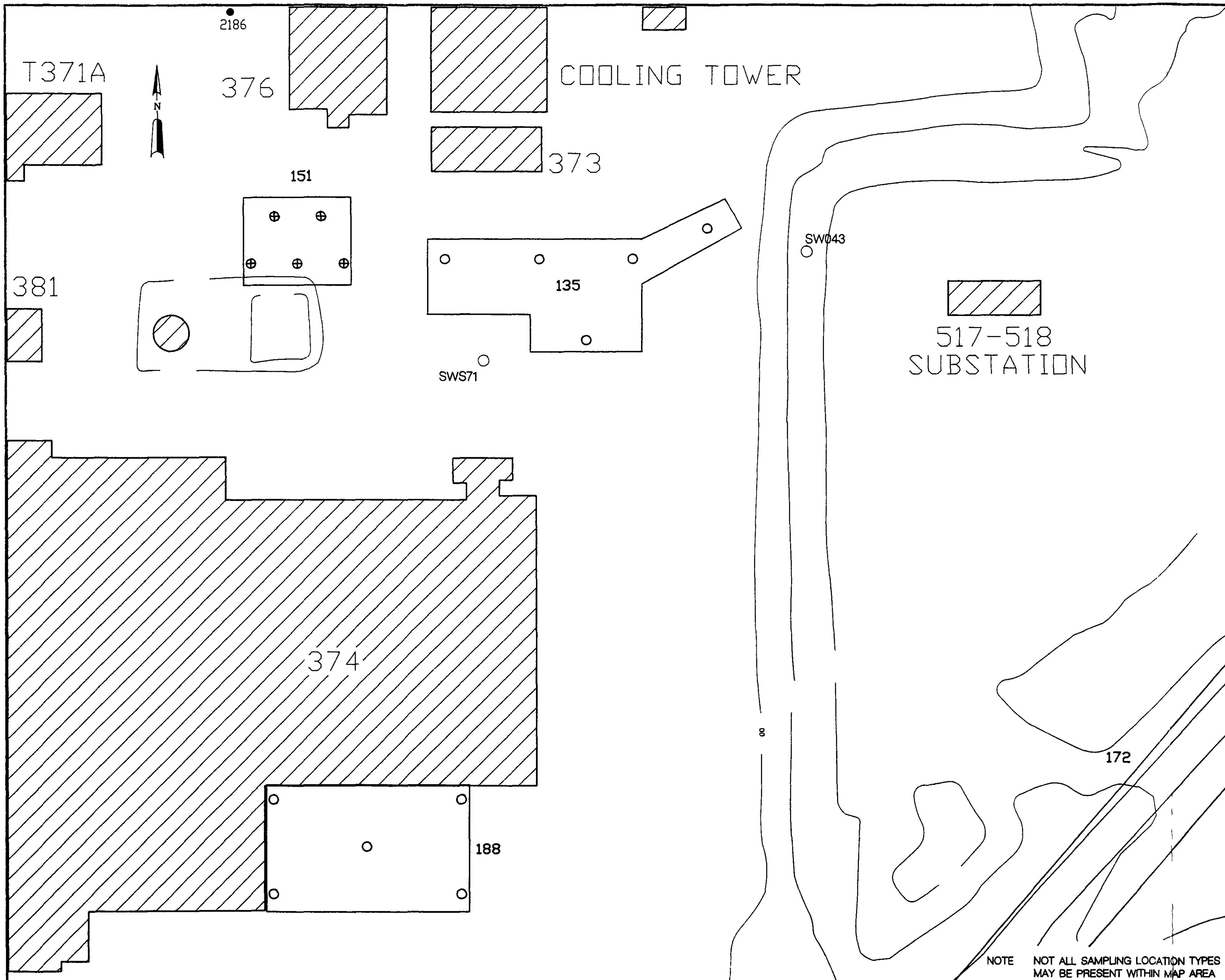
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 7

PROPOSED SAMPLING LOCATIONS
IHSS Nos 123 1

Approved By PSS Date 11/23/92

94/100



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

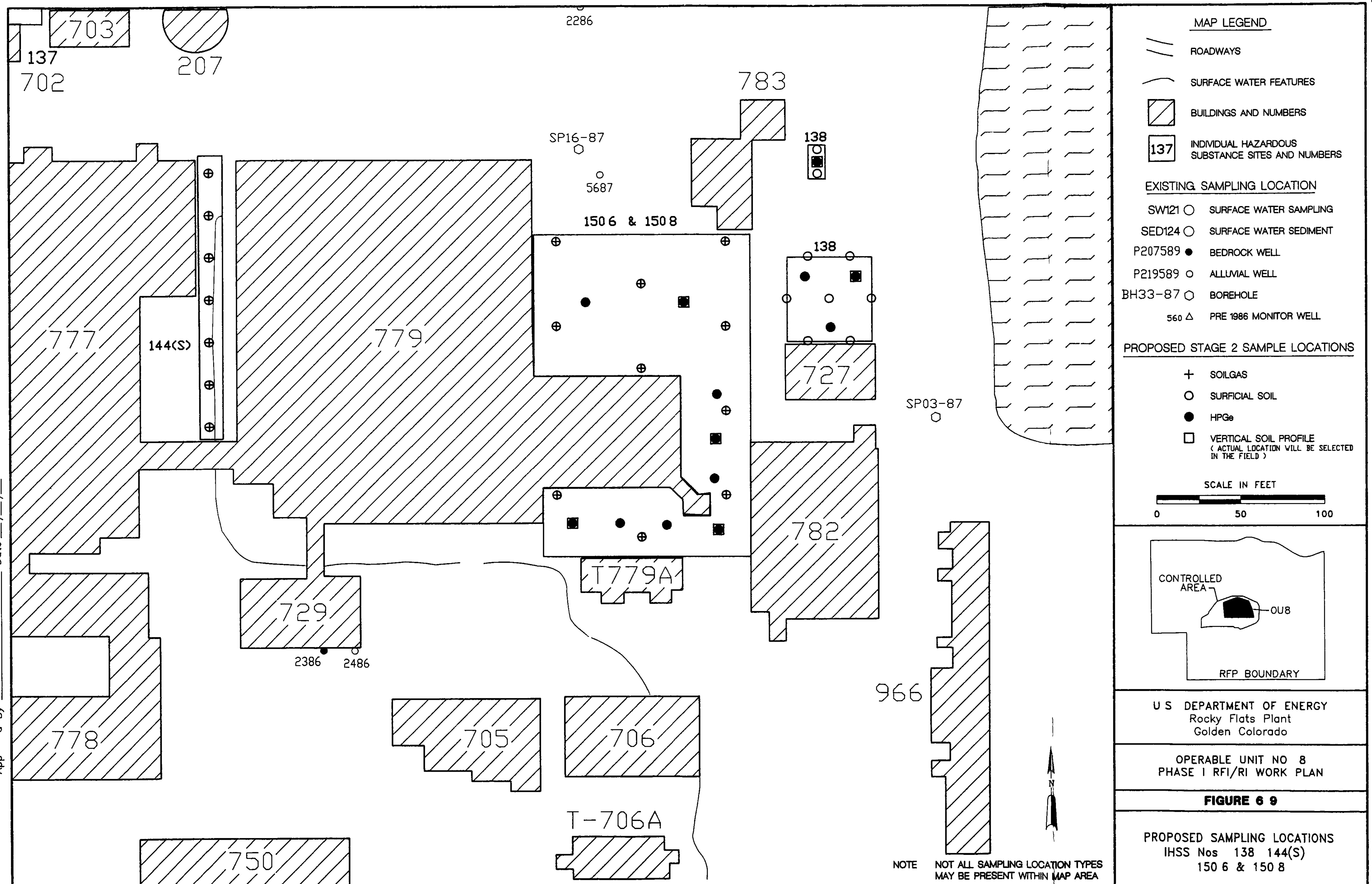
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 8

PROPOSED SAMPLING LOCATIONS
IHSS Nos 135 151 & 188

App d By PJJ D t 11/23/92

93/100



NOTE NOT ALL SAMPLING LOCATION TYPES MAY BE PRESENT WITHIN MAP AREA

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

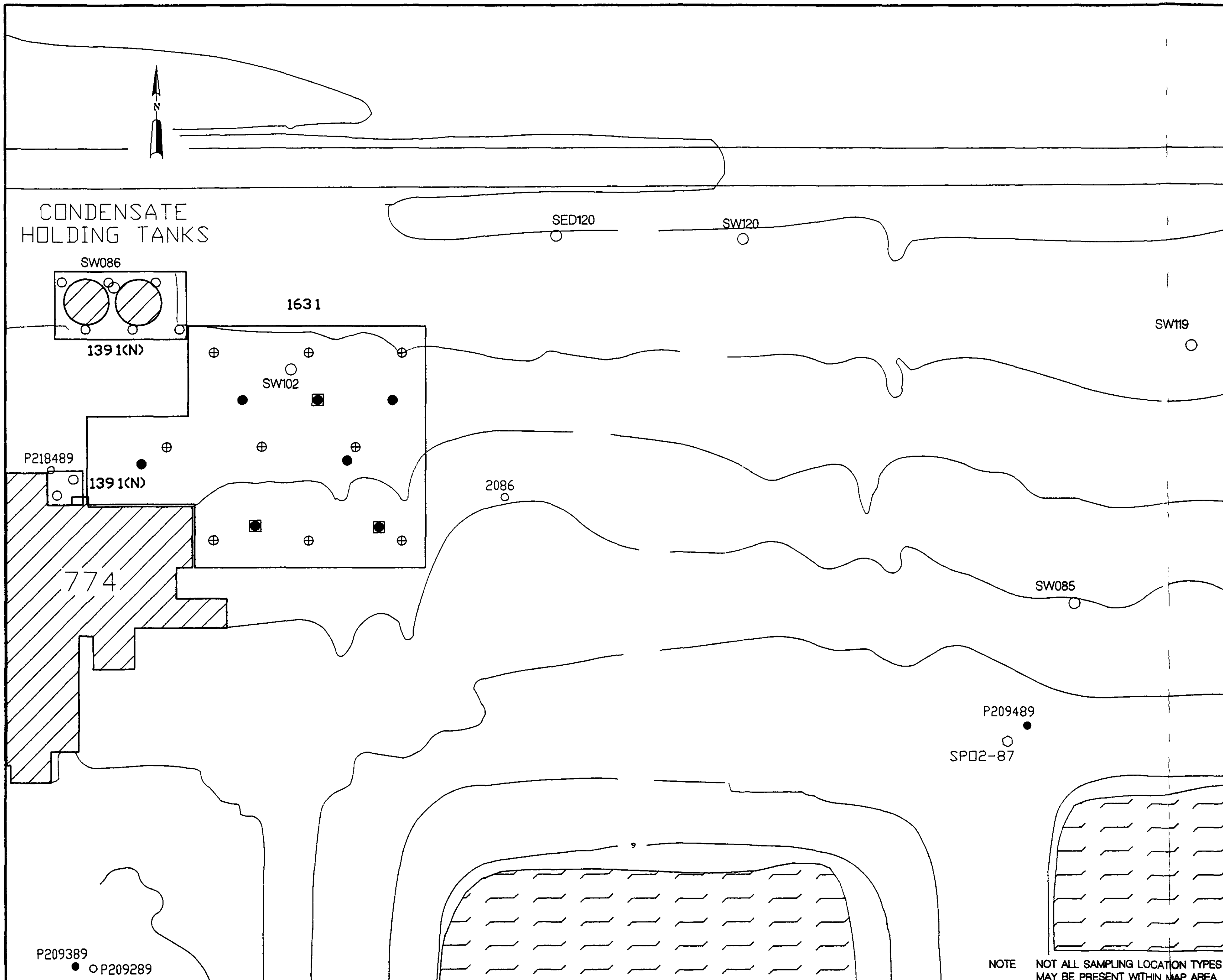
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 9

PROPOSED SAMPLING LOCATIONS
IHSS Nos 138 144(S)
150 6 & 150 8

App d By PJJ Date 11/23/12

96/100



Appro ed By PJJ Dt 11/23/92

File Nam OU86-10 DWG

MAP LEGEND

- ROADWAYS
- SURFACE WATER FEATURES
- BUILDINGS AND NUMBERS
- 137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND NUMBERS

EXISTING SAMPLING LOCATION

- SW121 ○ SURFACE WATER SAMPLING
- SED124 ○ SURFACE WATER SEDIMENT
- P207589 ● BEDROCK WELL
- P219589 ○ ALLUVIAL WELL
- BH33-87 ○ BOREHOLE
- 560 △ PRE 1986 MONITOR WELL

PROPOSED STAGE 2 SAMPLE LOCATIONS

- + SOILGAS
- ○ SURFICIAL SOIL
- ● HPGe
- □ VERTICAL SOIL PROFILE (ACTUAL LOCATION WILL BE SELECTED IN THE FIELD)

SCALE IN FEET

0 50 100

CONTROLLED AREA
OU8
RFP BOUNDARY

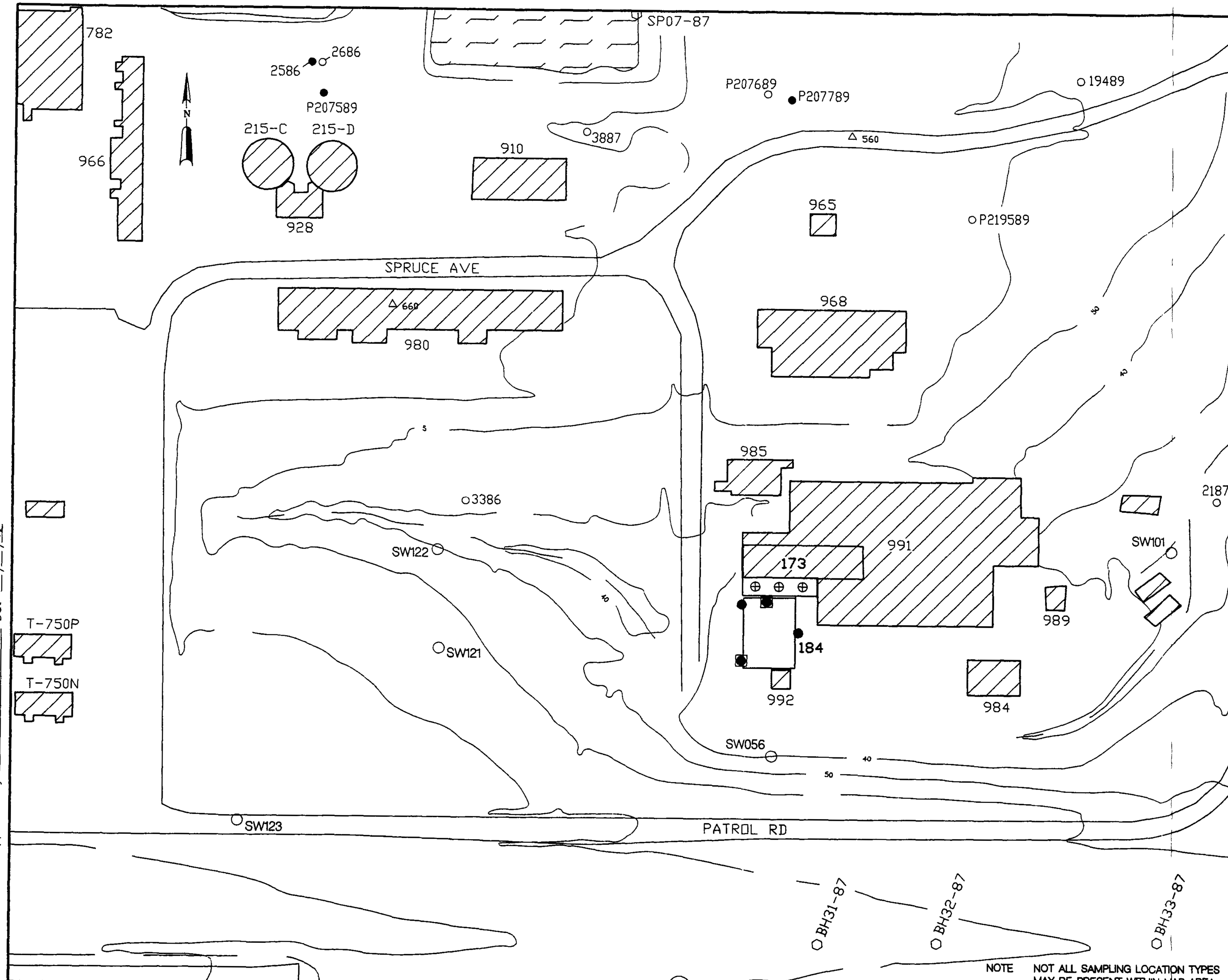
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 10

PROPOSED SAMPLING LOCATIONS
IHSS Nos 139 1(N) & 163 1

99/100



File Name OU86-13 DWG

MAP LEGEND

ROADWAYS

SURFACE WATER FEATURES

BUILDINGS AND NUMBERS

137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND NUMBERS

EXISTING SAMPLING LOCATION

SW121 SURFACE WATER SAMPLING

SED124 SURFACE WATER SEDIMENT

P207589 BEDROCK WELL

P219589 ALLUVIAL WELL

BH33-87 BOREHOLE

560 PRE 1986 MONITOR WELL

PROPOSED STAGE 2 SAMPLE LOCATIONS

+ SOILGAS

SURFICIAL SOIL

HPGe

VERTICAL SOIL PROFILE (ACTUAL LOCATION WILL BE SELECTED IN THE FIELD)

NOTE NOT ALL SAMPLING LOCATION TYPES MAY BE PRESENT WITHIN MAP AREA

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

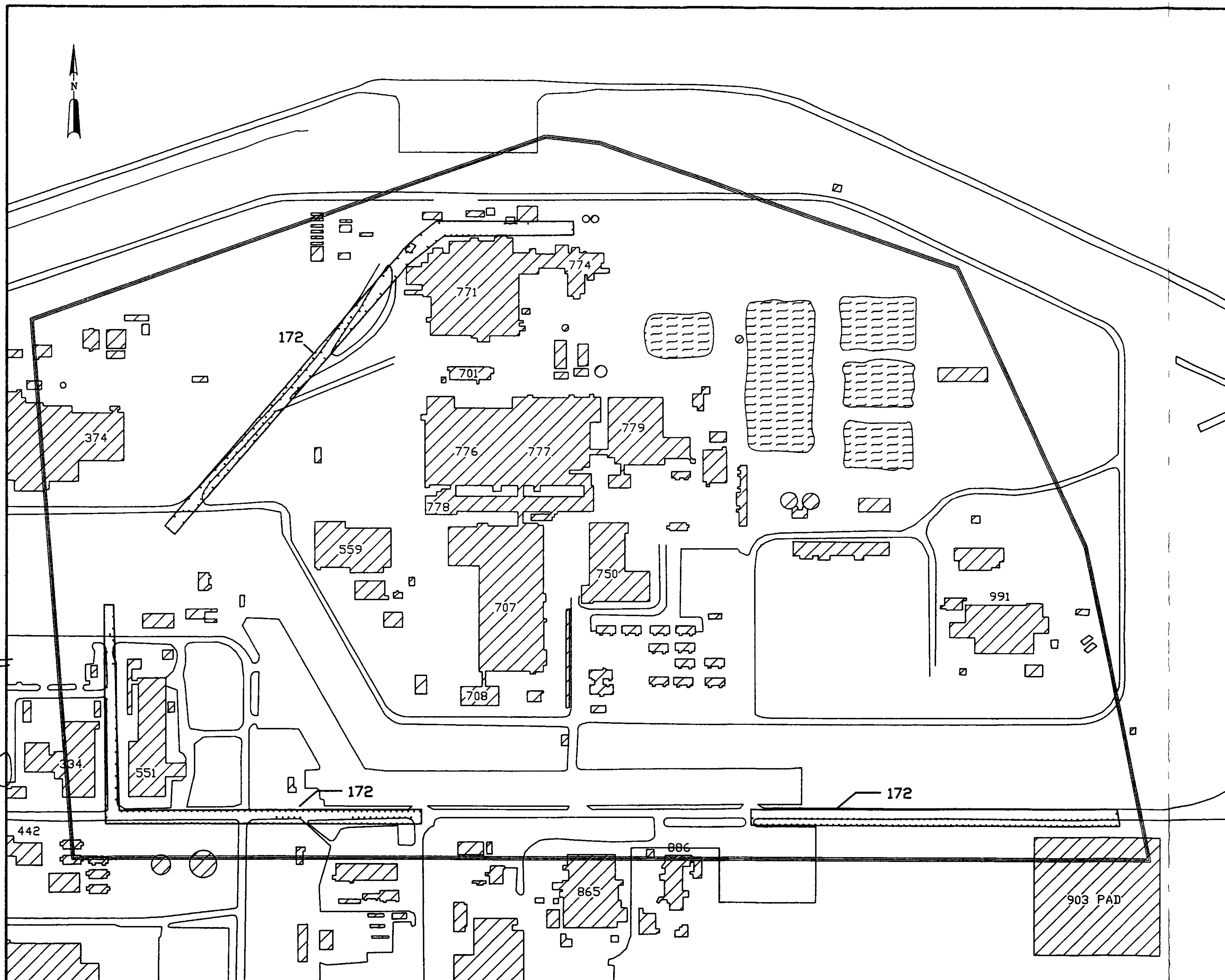
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 13

PROPOSED SAMPLING LOCATIONS
IHSS Nos 173 & 184

Approved By PJJ Dat 11/23/92

100/100



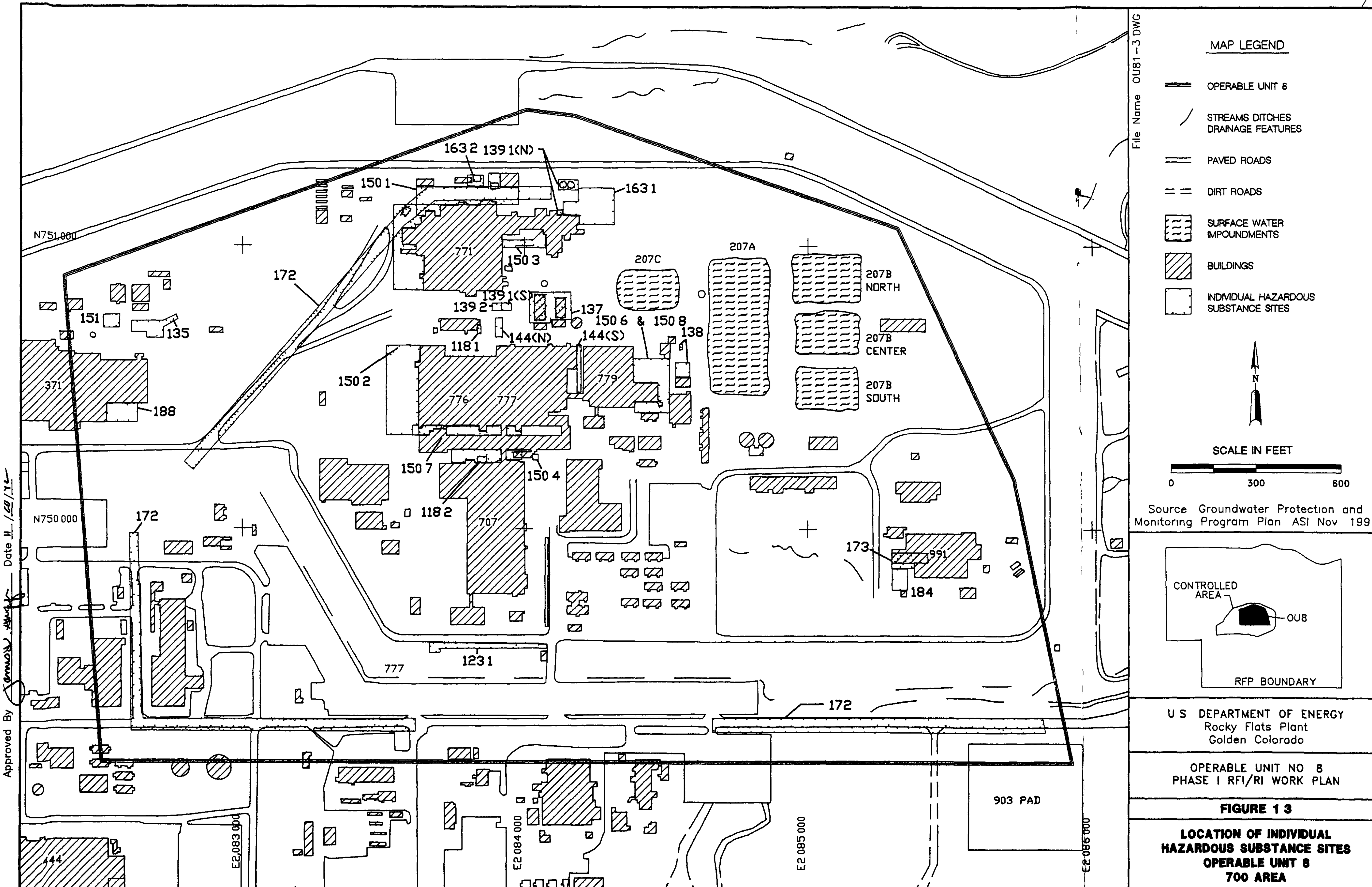
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 6 14

PROPOSED INVESTIGATION AREA
IHSS No 172

52/82



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Rocky Flats Plant
Golden Colorado

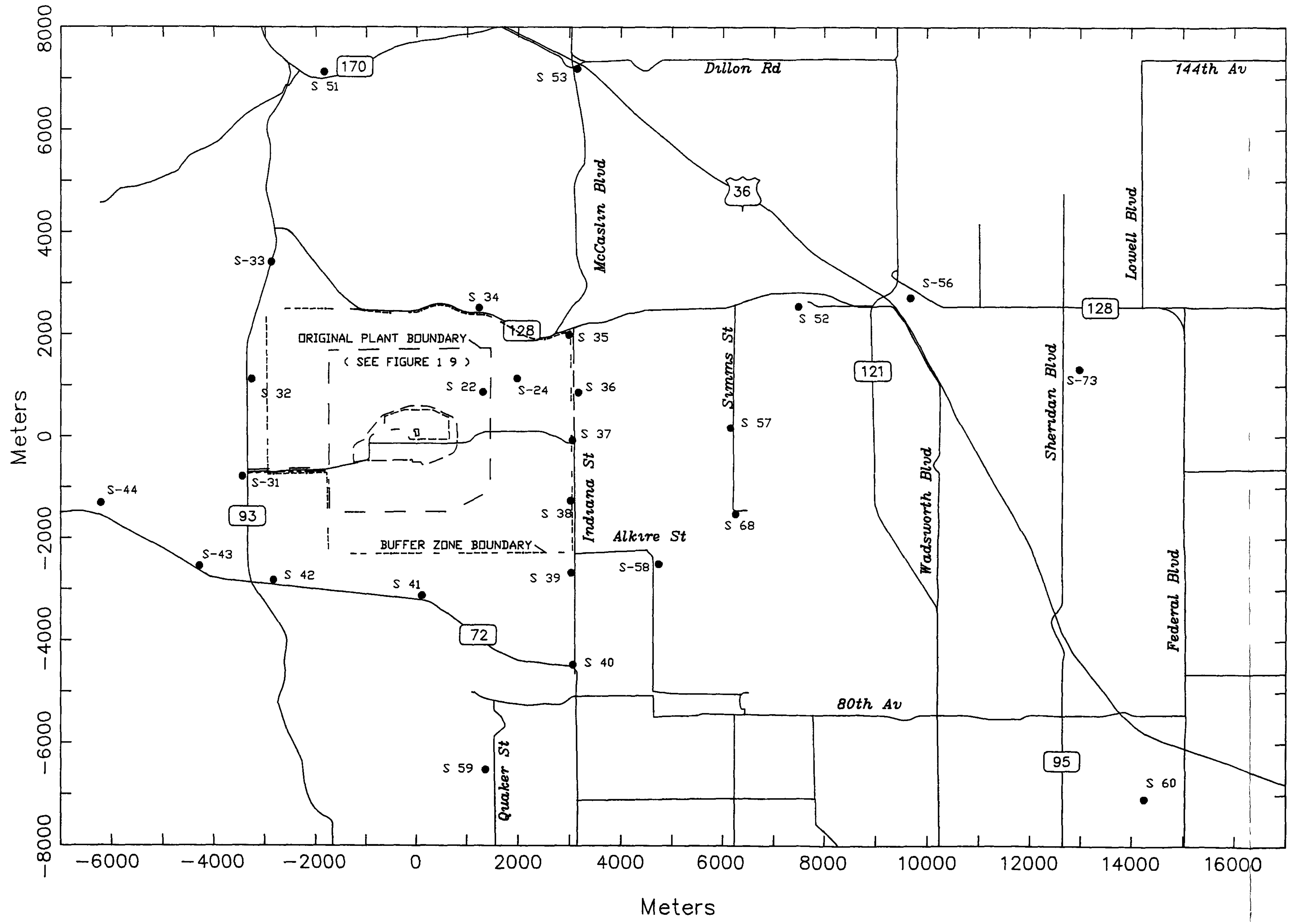
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 3

LOCATION OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES OPERABLE UNIT 8 700 AREA

Approved By [signature] Date 11/20/92

57/82



Approved By James D. [signature] Date 11/23/92

File Name OU81-8 DWG

MAP LEGEND

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Golden Colorado

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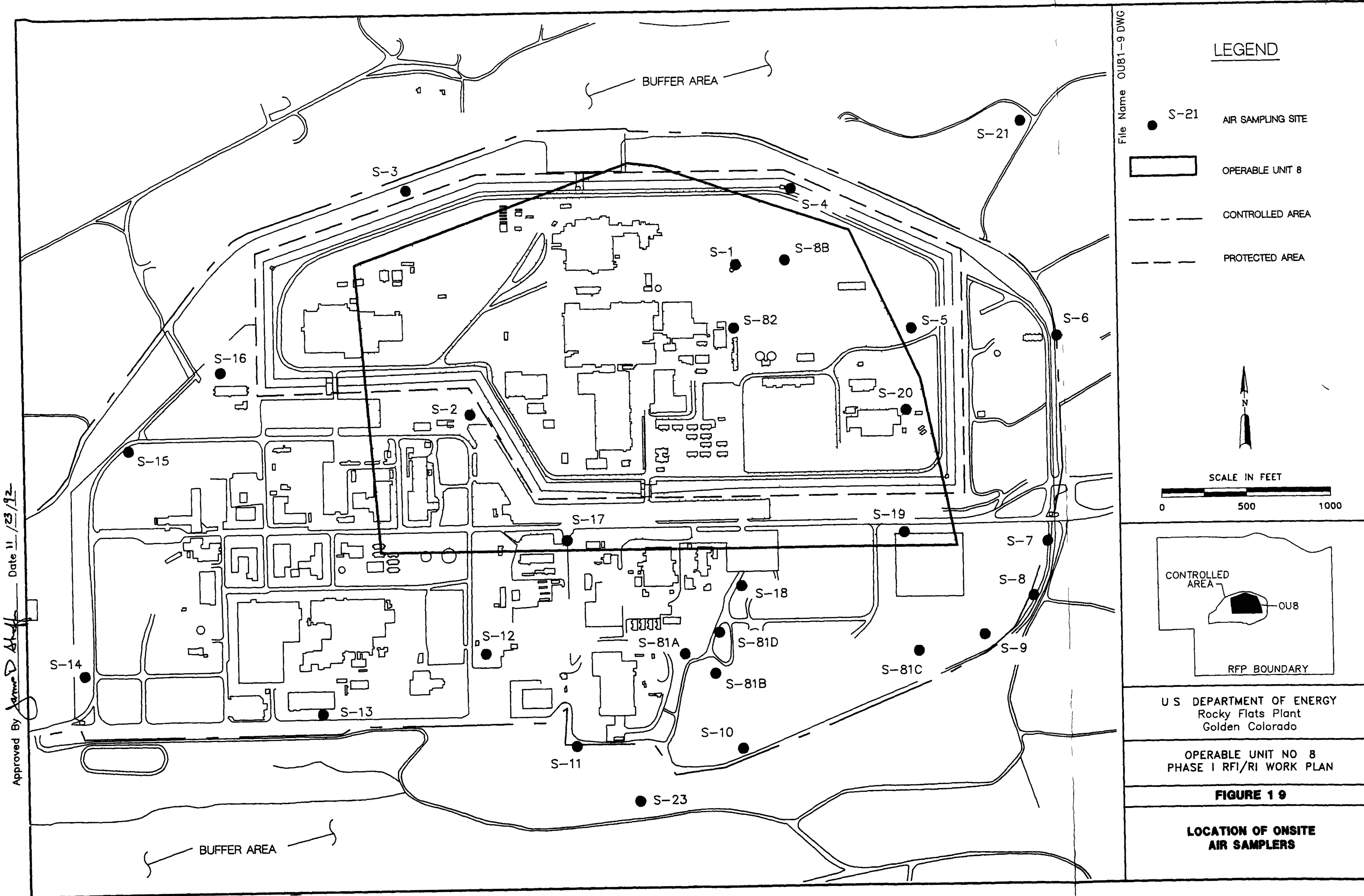
FIGURE 1 8

LOCATION OF ON-SITE AND PLANT PERIMETER AMBIENT AIR SAMPLERS

58/82



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Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
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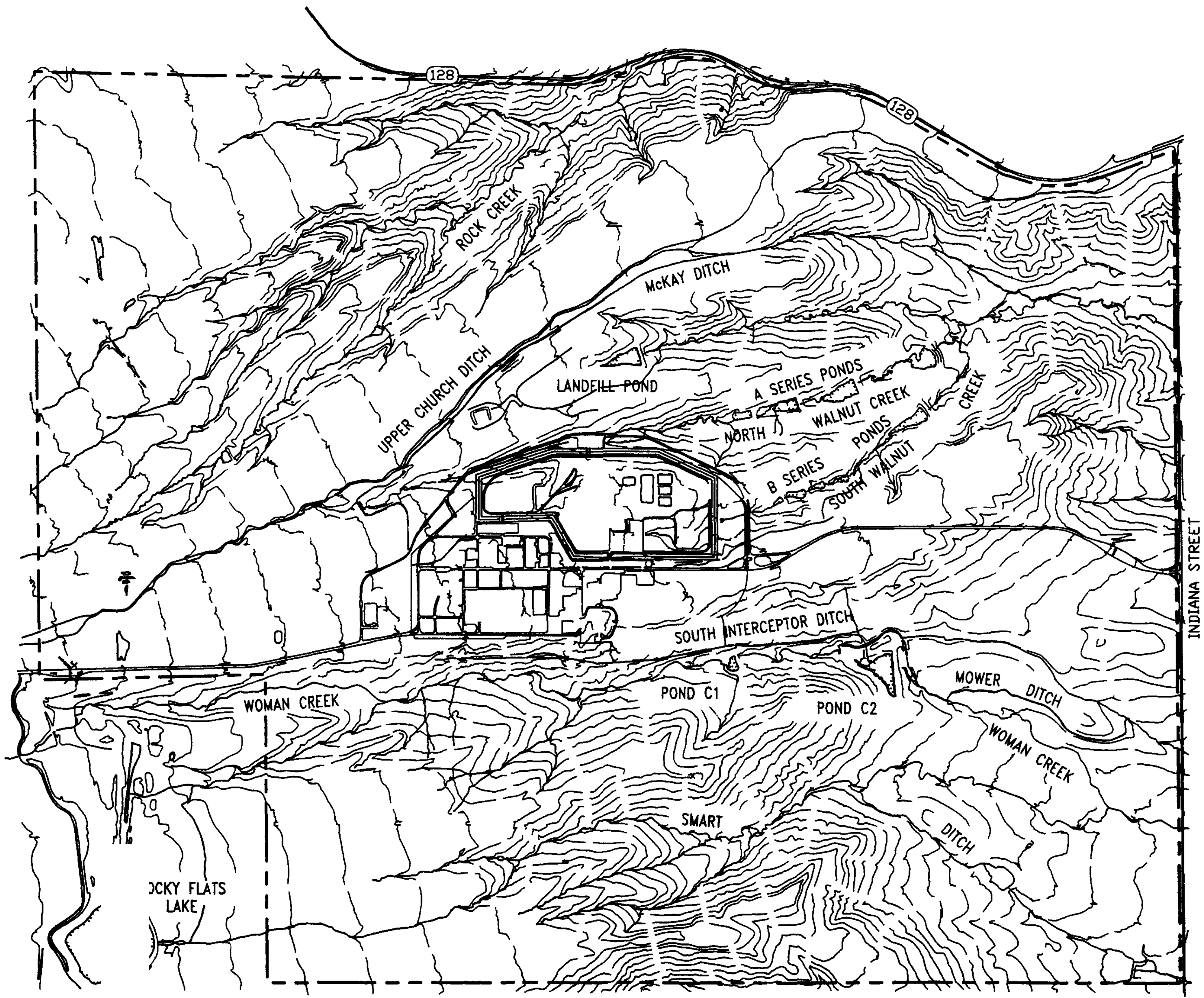
FIGURE 1 9

LOCATION OF ONSITE AIR SAMPLERS

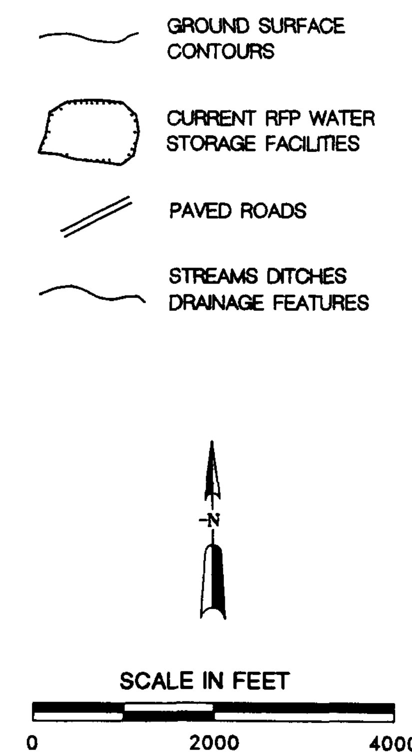
Approved By James D [signature] Date 11 /23/92

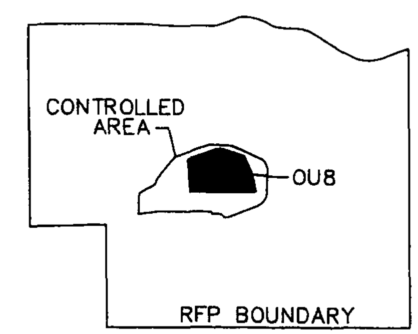
62/82



File Name OU81-8 DWG

EXPLANATION





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Rocky Flats Plant
Golden Colorado

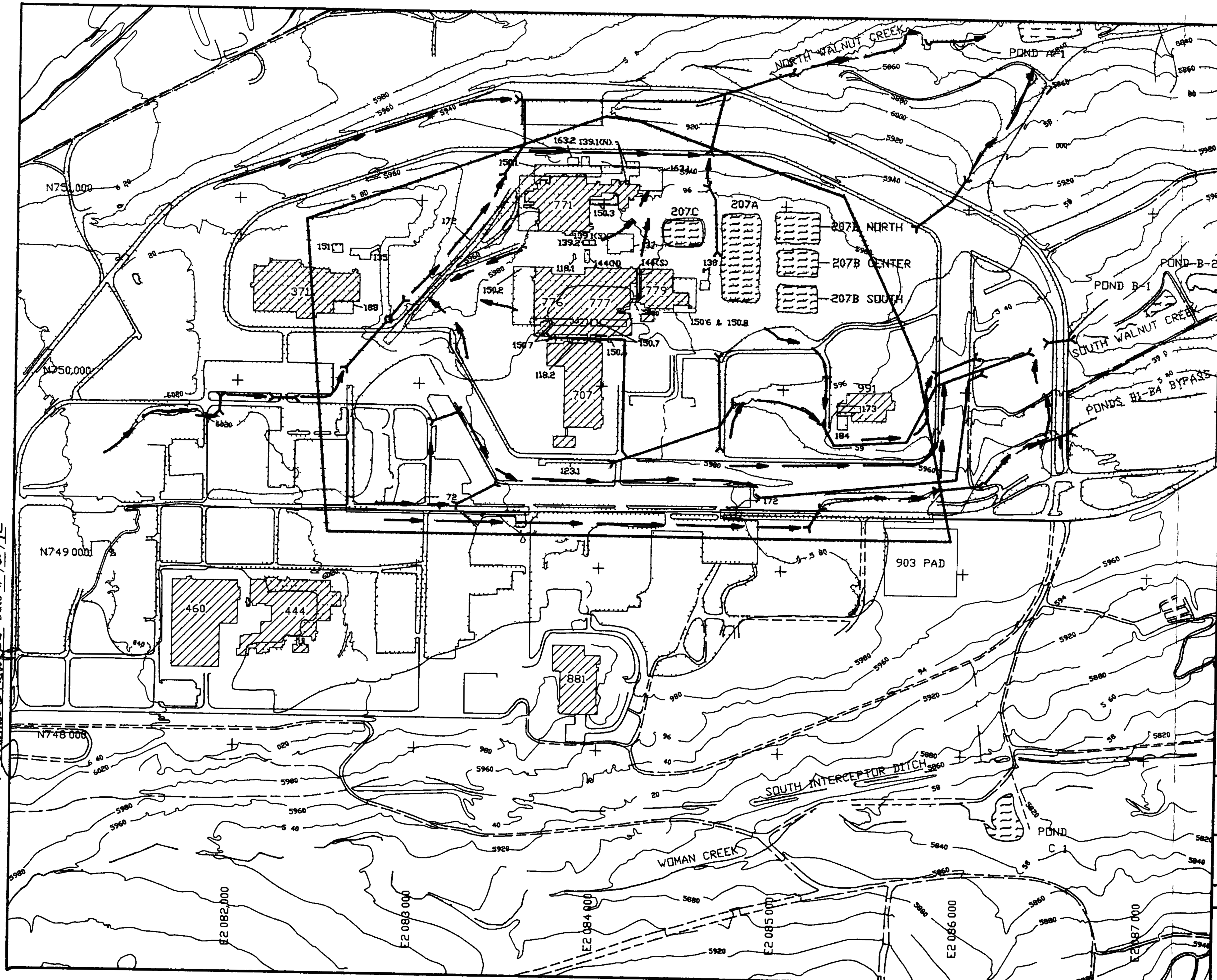
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 13

LOCATION OF SURFACE WATER FEATURES

Approved By I Smarl Date 10/20/92

64/82



File Nam OU81-15 DWG

MAP LEGEND

- OPERABLE UNIT
- 163.2 INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- STORM DRAINS
- DRAINAGE FLOW PATHS

DRAINAGE BASINS

- NORTH WALNUT CREEK DRAINAGE BASIN
- UPPER S. WALNUT CREEK DRAINAGE BASIN
- LOWER S. WALNUT CREEK DRAINAGE BASIN

N

SCALE IN FEET

0 500 1000

SCALE 1 = 500

CONTROLLED AREA

OU8

RFP BOUNDARY

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

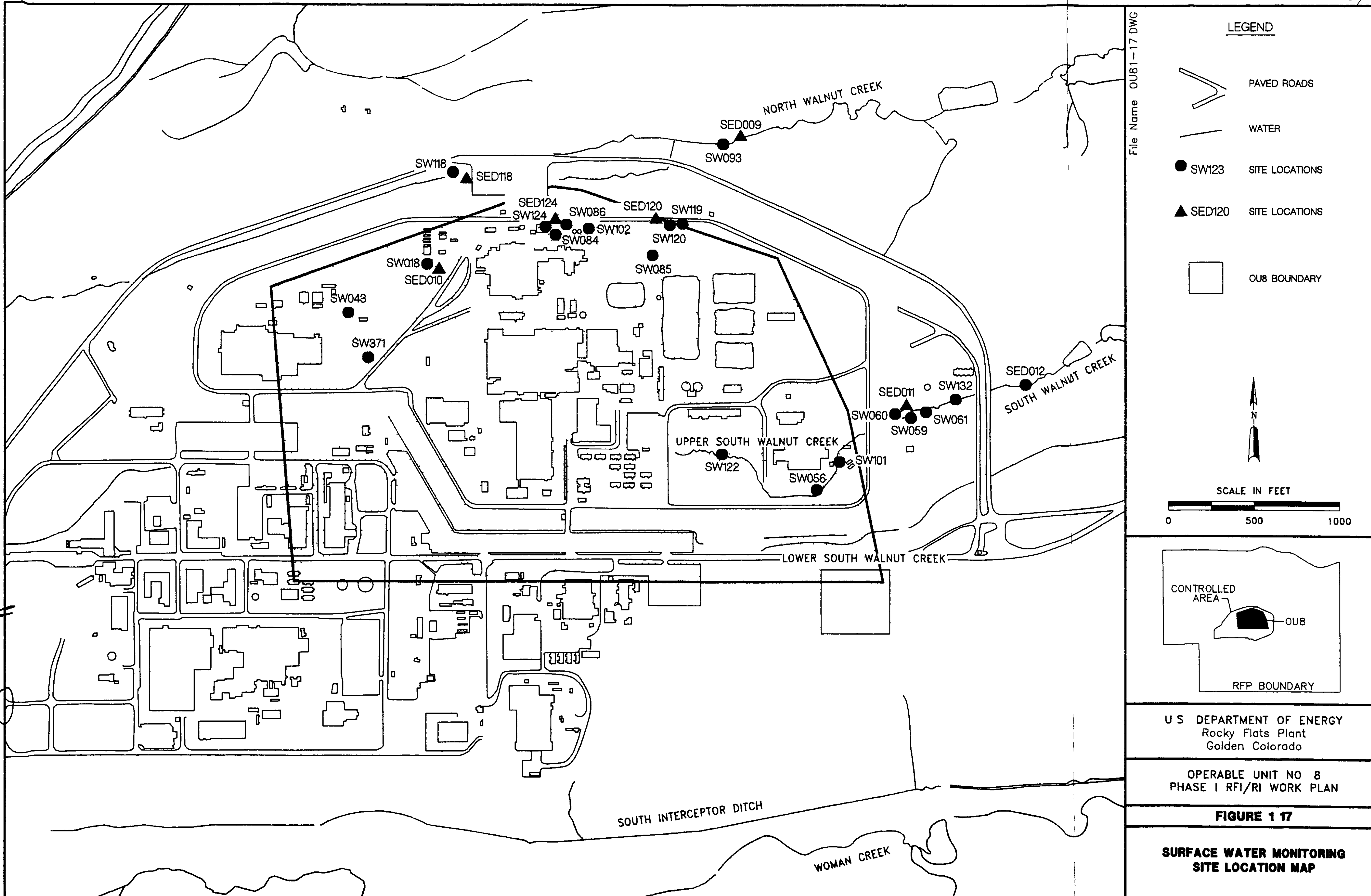
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-15

SURFACE WATER DRAINAGE BASINS AND DRAINAGE SYSTEMS

Approved By [signature] Date 11/20/92

66/82



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Rocky Flats Plant
Golden Colorado

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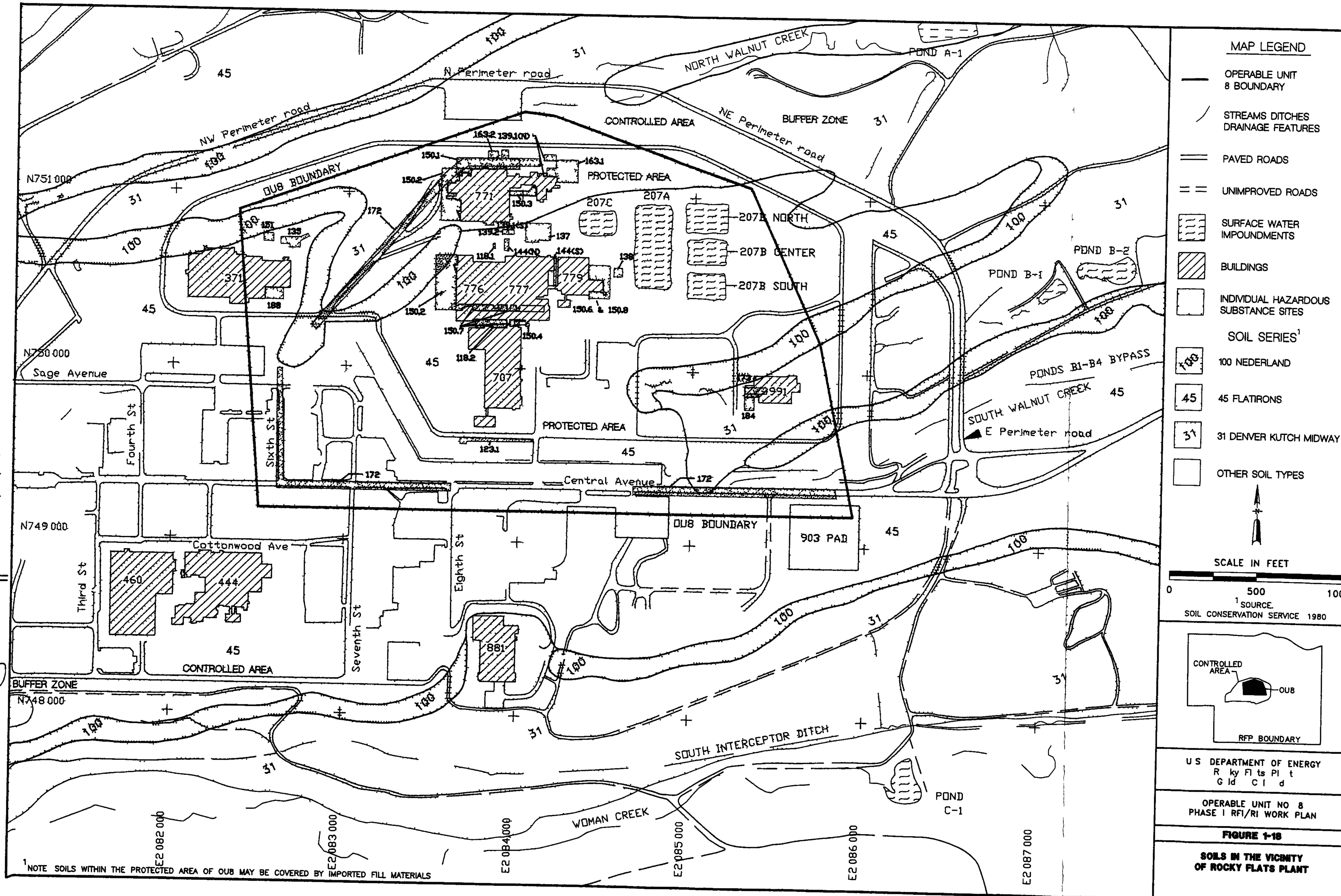
PHASE I RFI/RI WORK PLAN

FIGURE 1 17

SURFACE WATER MONITORING SITE LOCATION MAP

Approved By [signature] Date 11/20/92

67/82



U S DEPARTMENT OF ENERGY
R ky Fl ts Pl t
G ld C l d

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

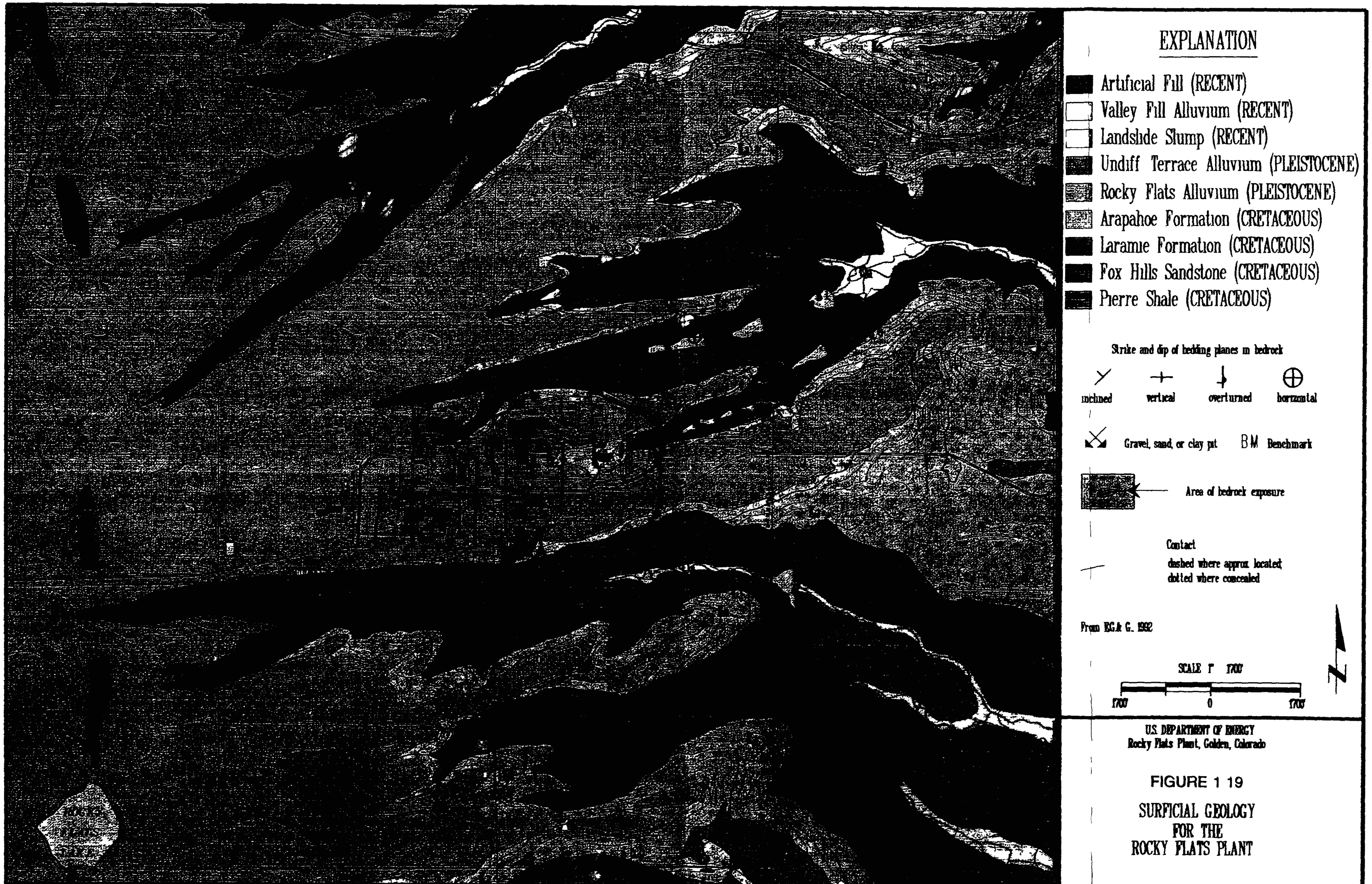
FIGURE 1-18

SOILS IN THE VICINITY OF ROCKY FLATS PLANT

[1] NOTE SOILS WITHIN THE PROTECTED AREA OF OU8 MAY BE COVERED BY IMPORTED FILL MATERIALS

Approved By James D Mullen Date 11/20/92

68/82

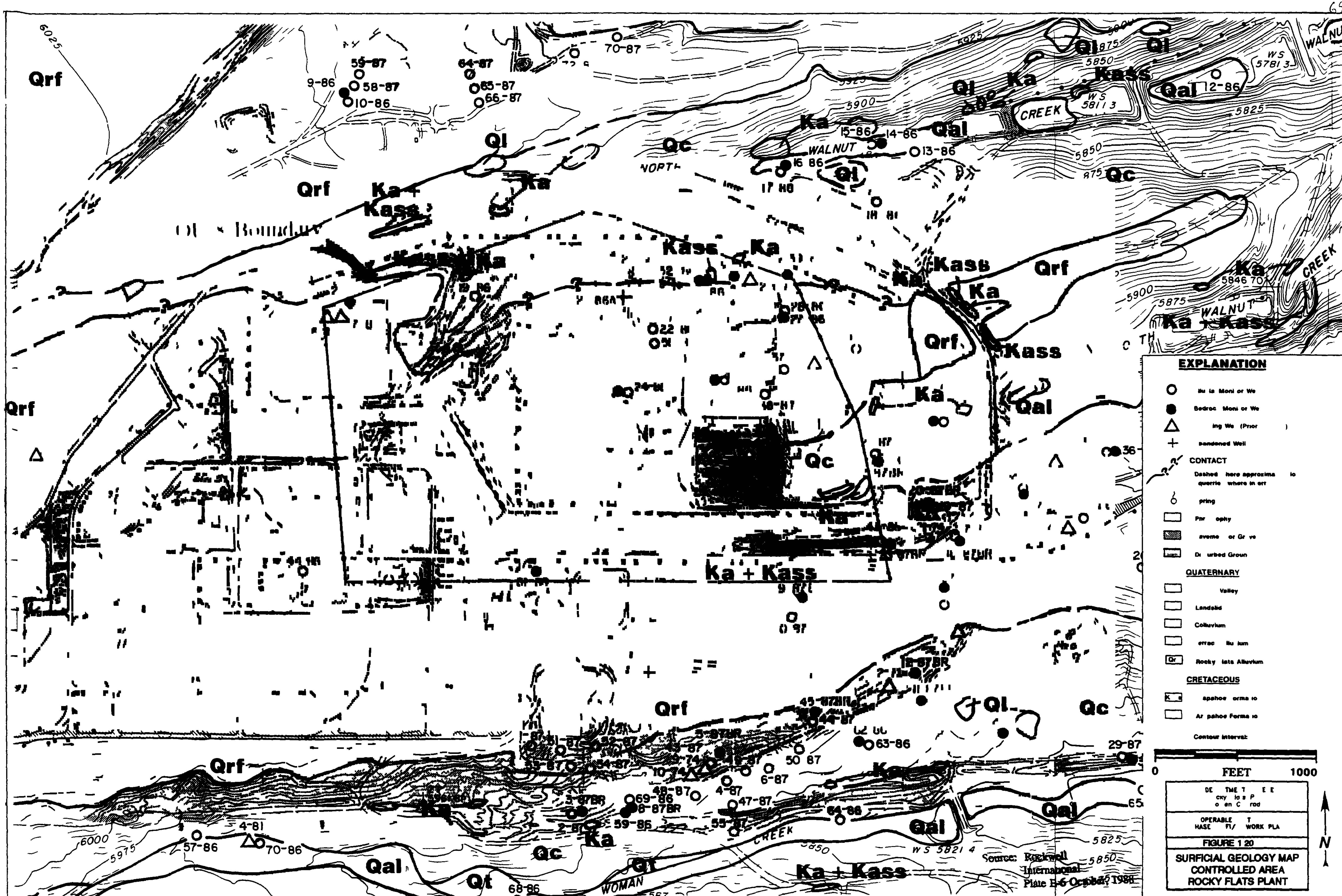


US DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

FIGURE 1 19

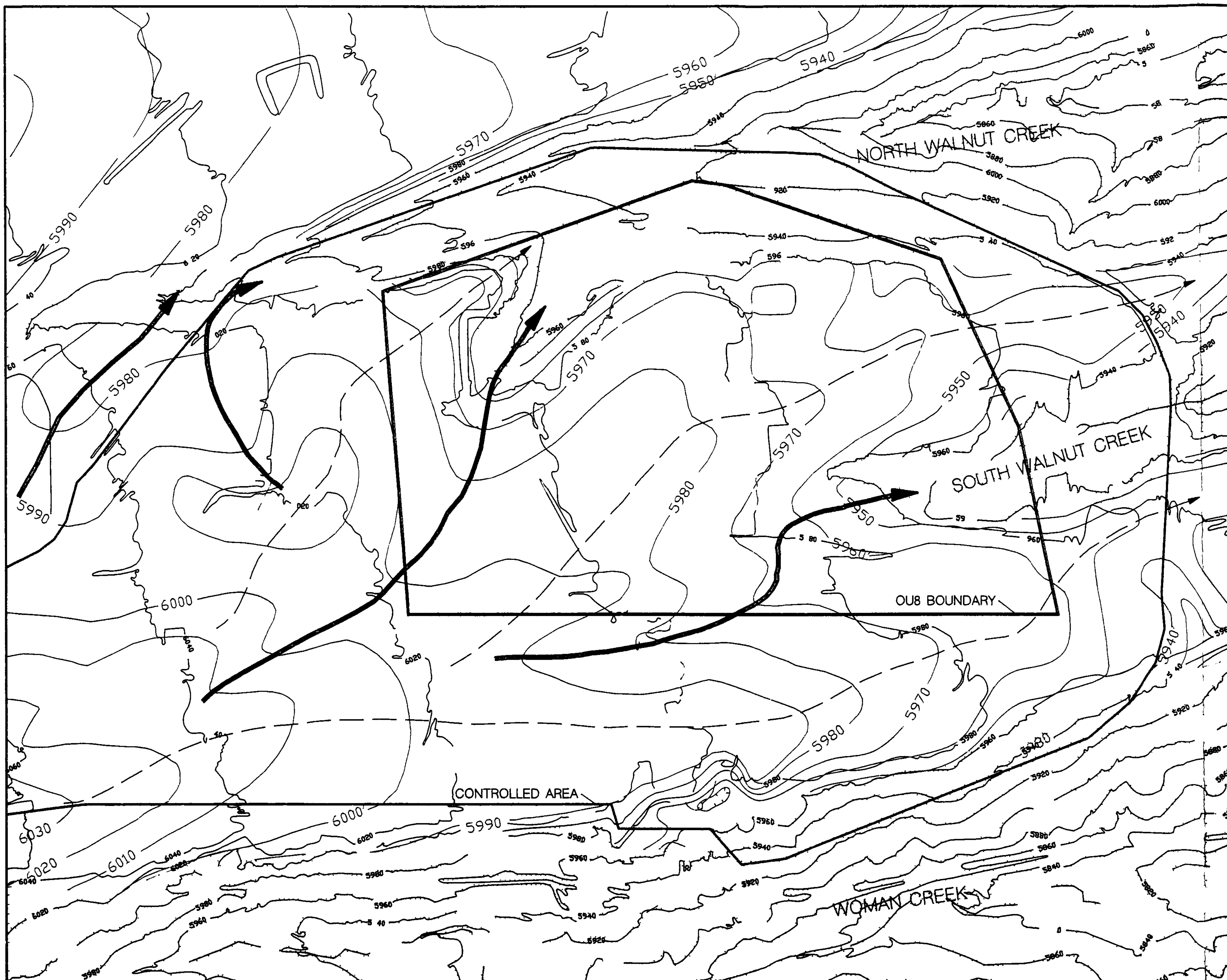
SURFICIAL GEOLOGY
FOR THE
ROCKY FLATS PLANT

69/82



Appro ed By [signature] Date 10/28/92

70/82



OU81-16 DWG

LEGEND

PRESENT DAY FEATURES

880 — GROUND SURFACE ELEVATION

CREEKS

AREA SUBJECT TO EROSION AT PEDIMENT DUE TO LOSS OF ROCKY FLATS ALLUVIUM

LATE WISCONSIN AGE GEOMORPHOLOGY

AREA OF PEDIMENT PRESERVED BY ROCKY FLATS ALLUVIUM

5940 — PEDIMENT ELEVATION

PALEO RIDGE

PALEO DRAINAGE

N

SCALE IN FEET

0 500 1000

CONTROLLED AREA

OU8

RFP BOUNDARY

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

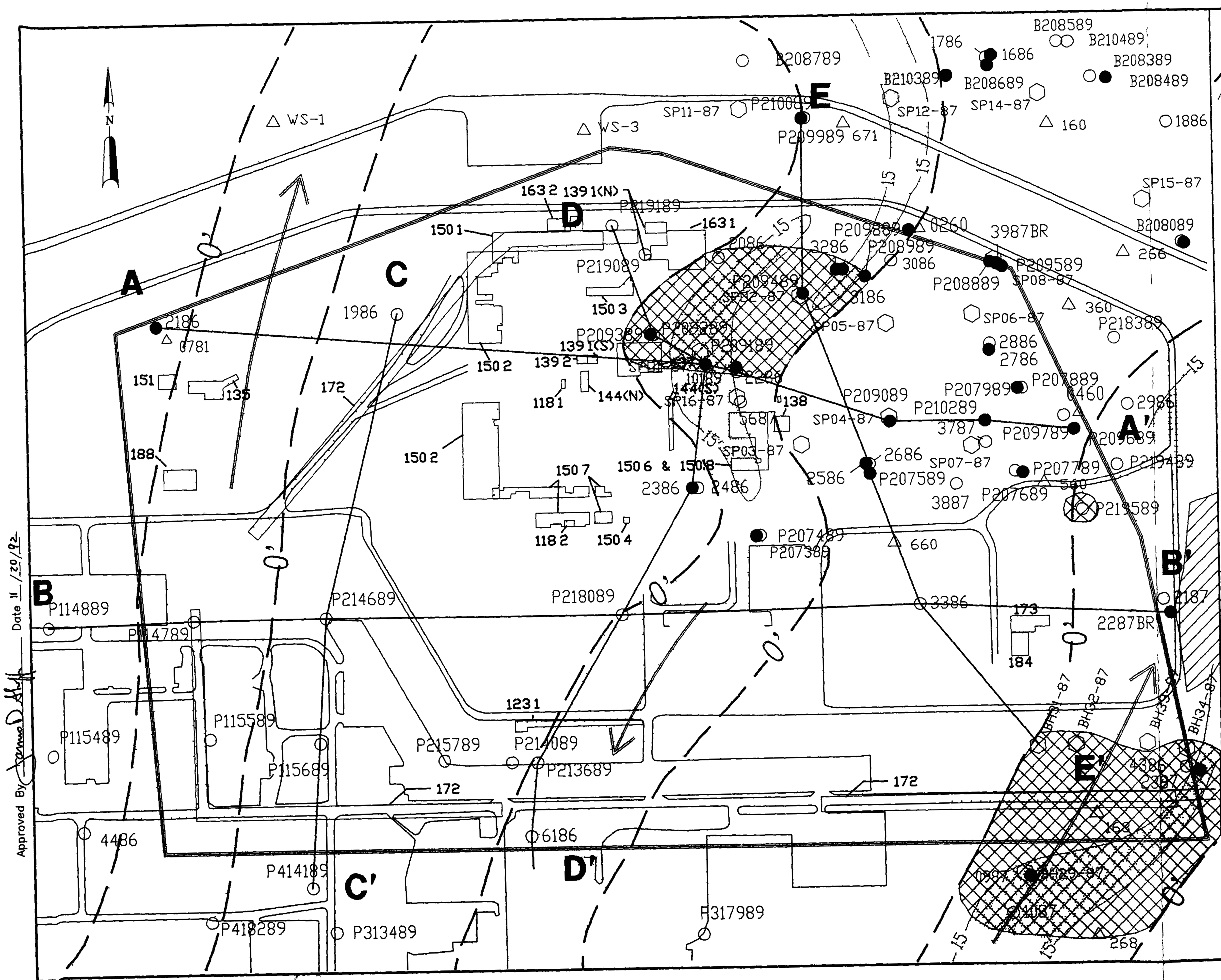
FIGURE 1 21

MAP OF PRESENT DAY TOPOGRAPHY AND SUBSURFACE PRESERVED PRE ROCKY FLATS ALLUVIUM PEDIMENT SURFACE

App d By [signature] D t 10/28/92

17

73/82



LEGEND

THICKNESS OF FLUVIAL DEPOSITS

FLUVIAL TRANSPORT DIRECTION

HOLOCENE ERODED

149 INDIVIDUAL HAZARDOUS SUBSTANCE SITES

ARAPAHOE NO. 1 SANDSTONE SUBCROPPING BENEATH SURFICIAL MATERIALS (POTENTIAL HYDRAULIC INTERCONNECTION)

CROSS SECTION

OU 8 BOUNDARY

ALLUVIAL MONITOR WELLS

BEDROCK MONITOR WELLS

ABANDONED BORHOLE/WELLS

BOREHOLE

SCALE IN FEET

0 300 600

CONTROLLED AREA

OU8

RFP BOUNDARY

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 24

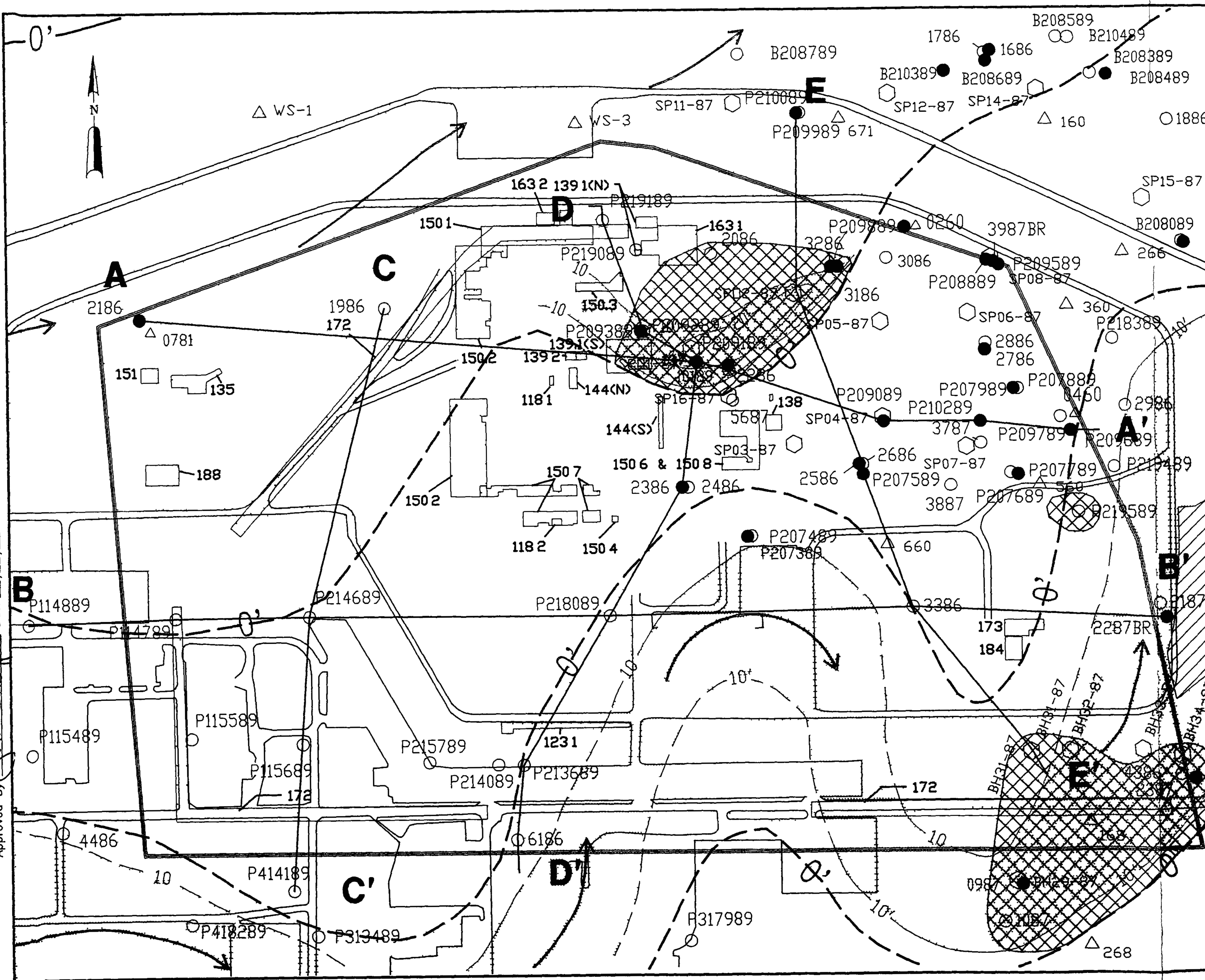
ISOPACH OF NO 1 SANDSTONE INTERPRETATION 1

AFTER FIG 14 EG&G 1991h

File Name OU81-24 DWG

Approved By [signature] Date 11/20/92

74/82



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

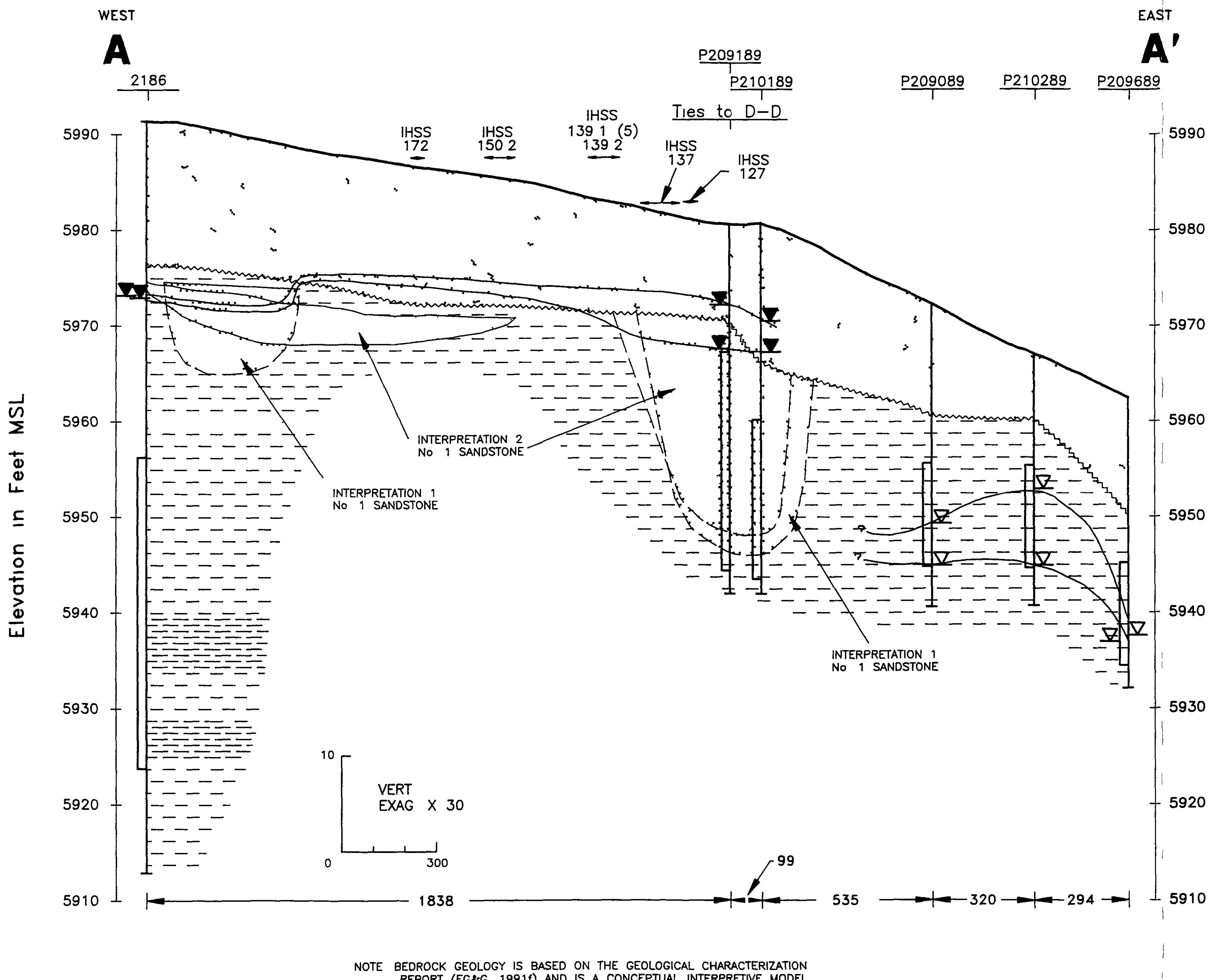
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 25

ISOPACH OF NO 1 SANDSTONE INTERPRETATION 2

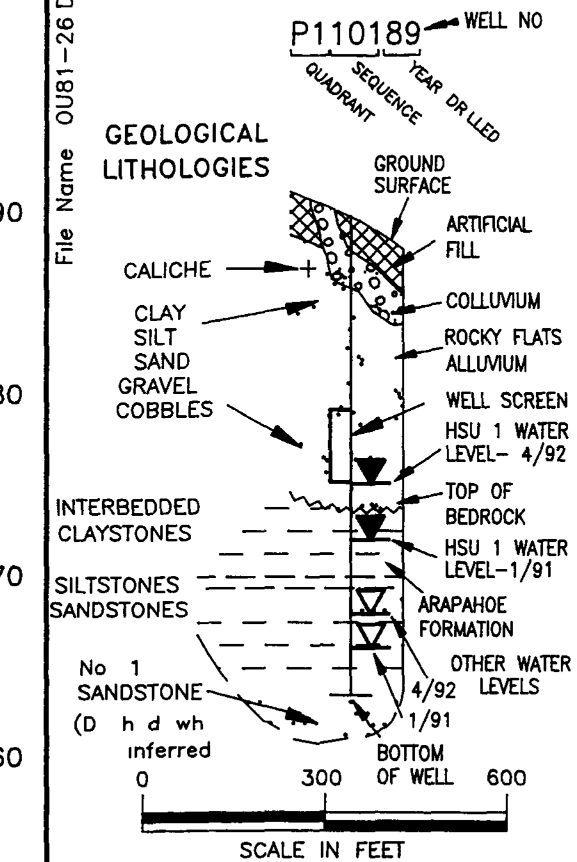
AFTER FIG 15 EG&G 1991h

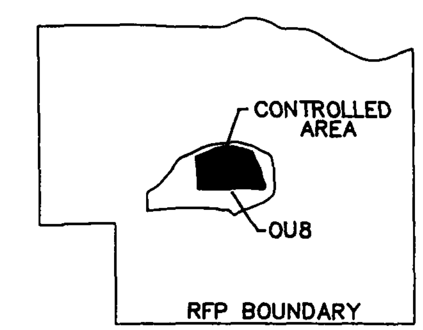
75/82



File Name OU81-26 DWG

LEGEND





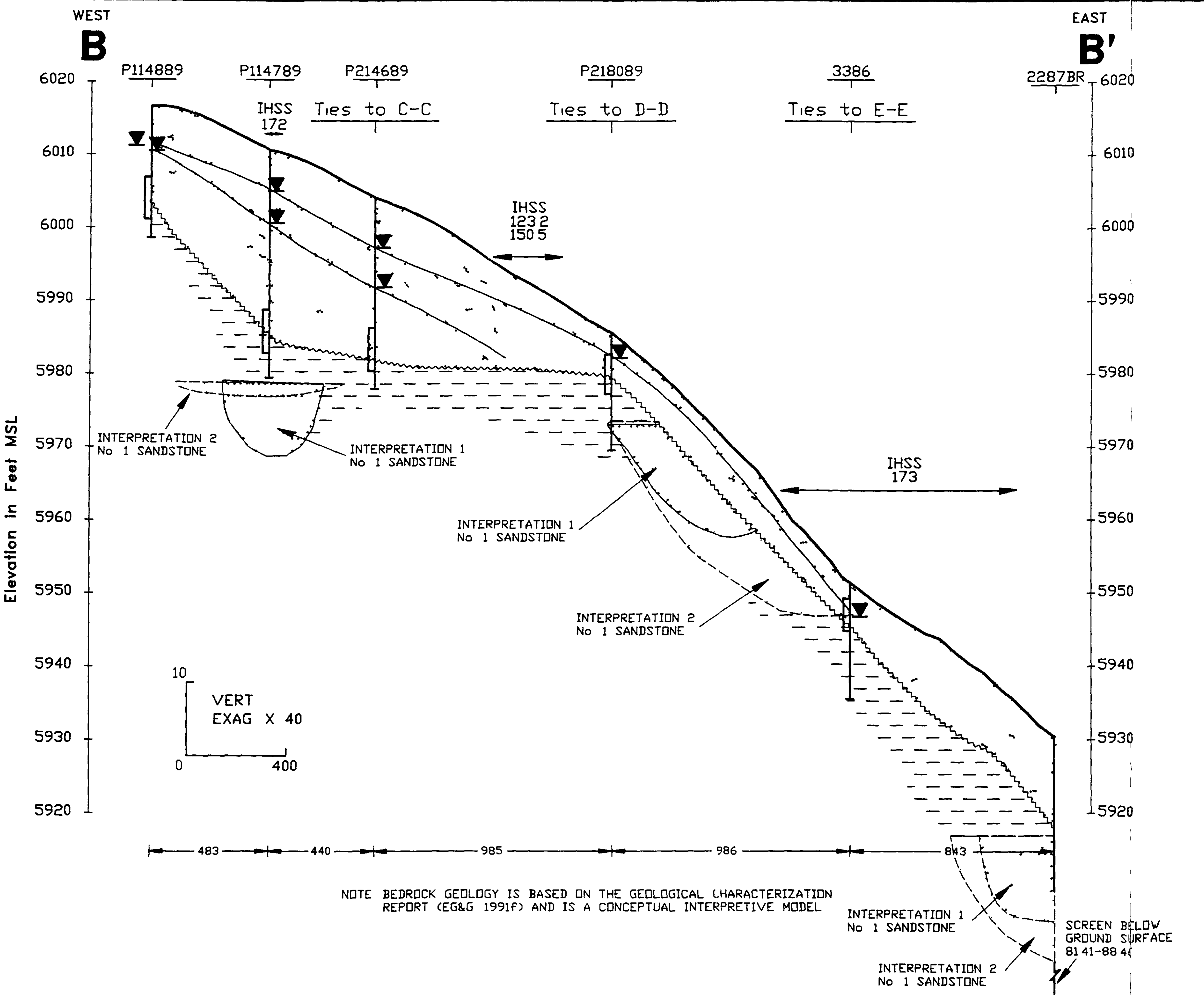
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

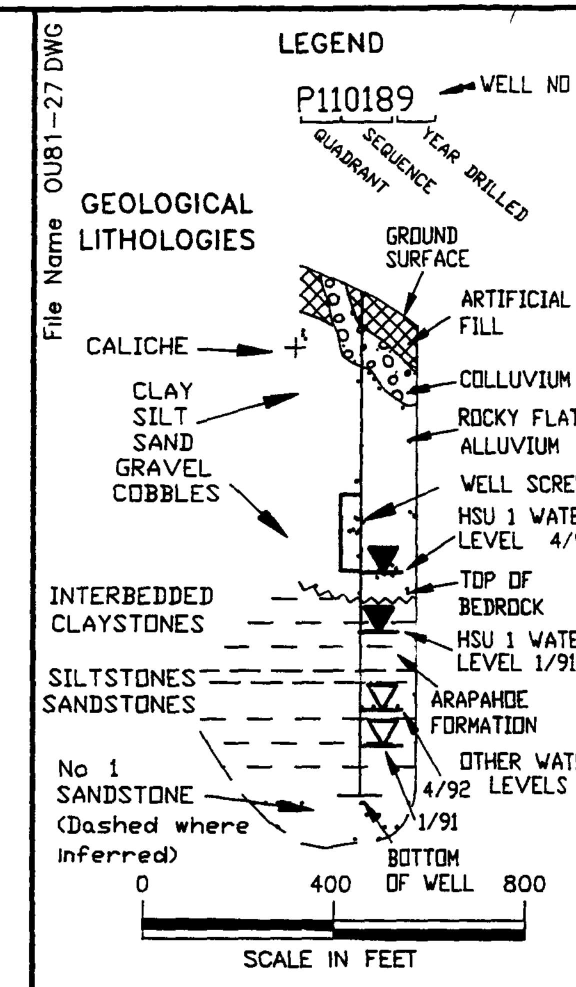
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

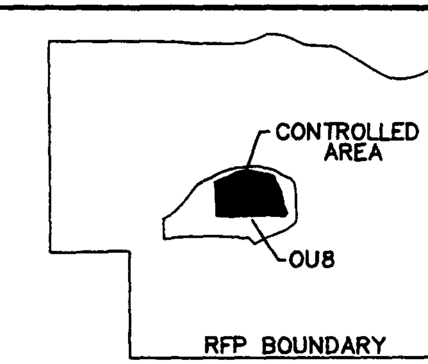
FIGURE 1 26

GEOLOGICAL CROSS SECTION A A

Appro ed By [signature] Date 11 /23/92







U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

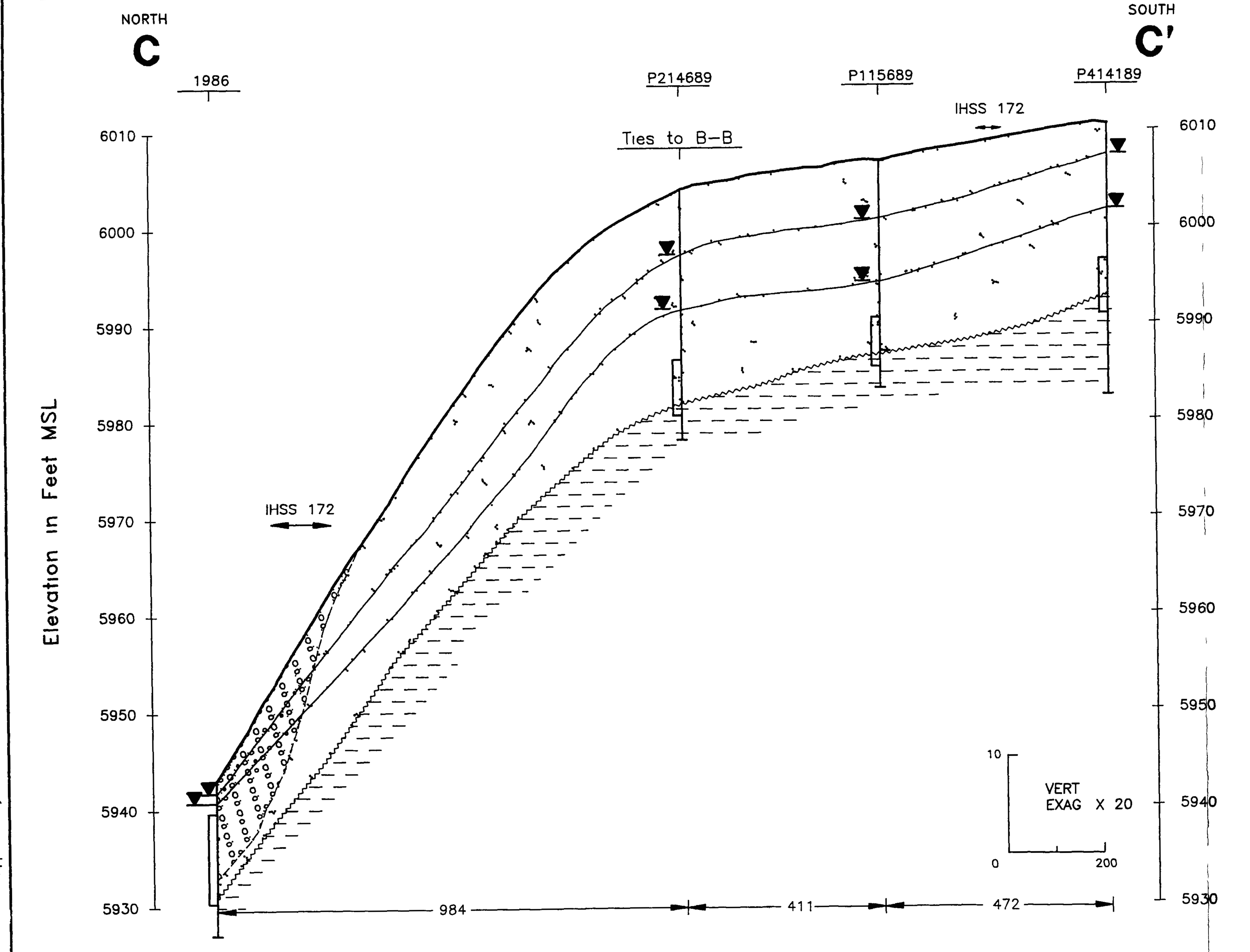
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 27

GEOLOGICAL CROSS SECTION
B-B

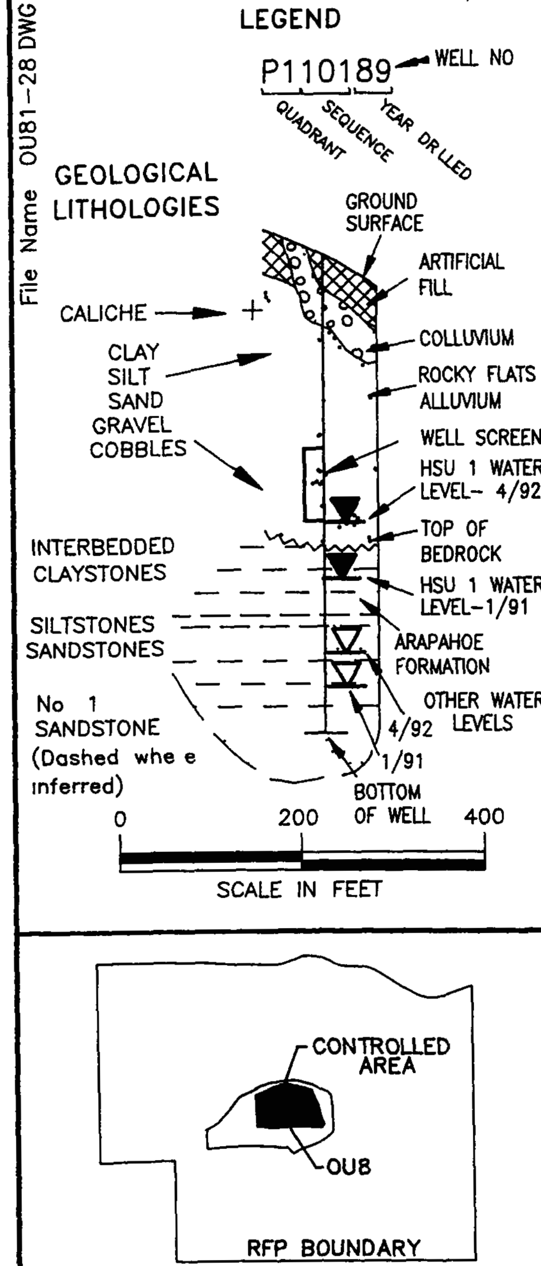
Approved By [signature] Date 11/23/92

77/82



NOTE BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL

File Name OU81-28 DWG



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

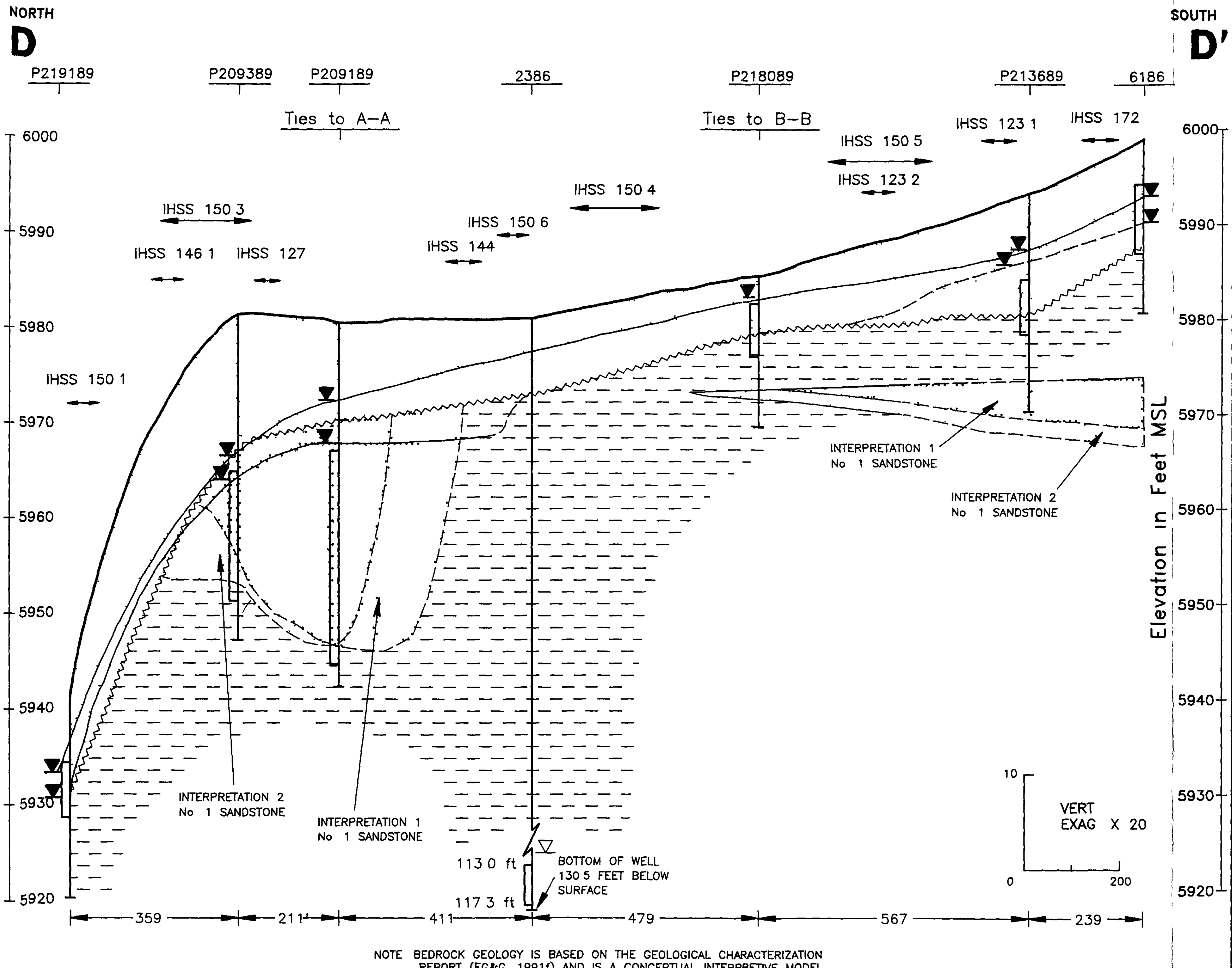
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

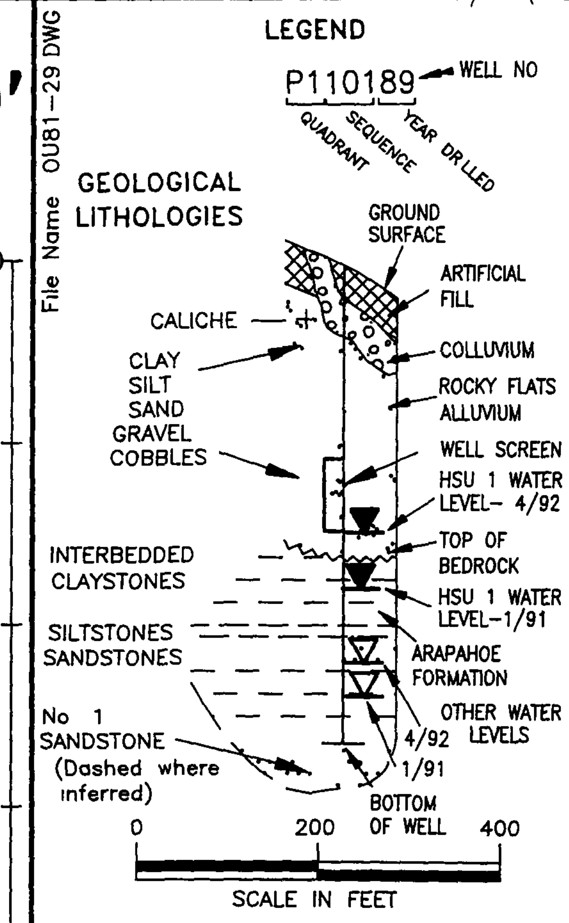
FIGURE 1 28

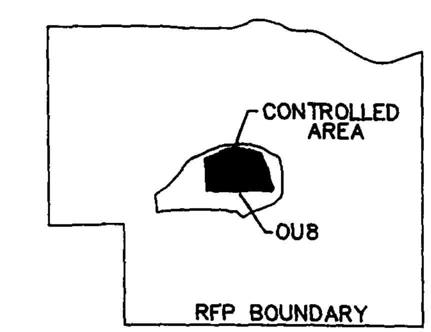
GEOLOGICAL CROSS SECTION
C C

Approved By Tim A Paschke Date 11/23/92

78/82







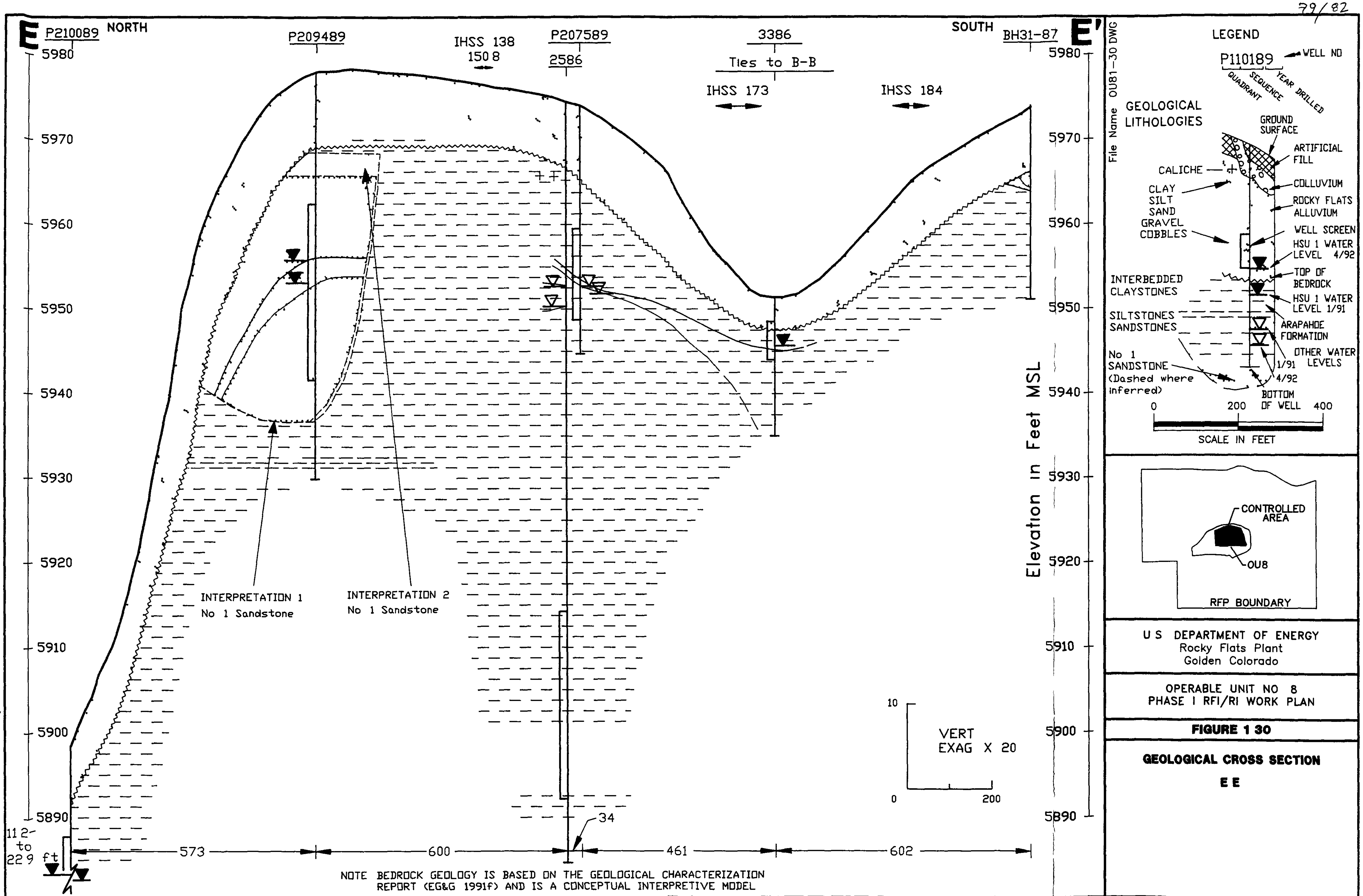
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 29

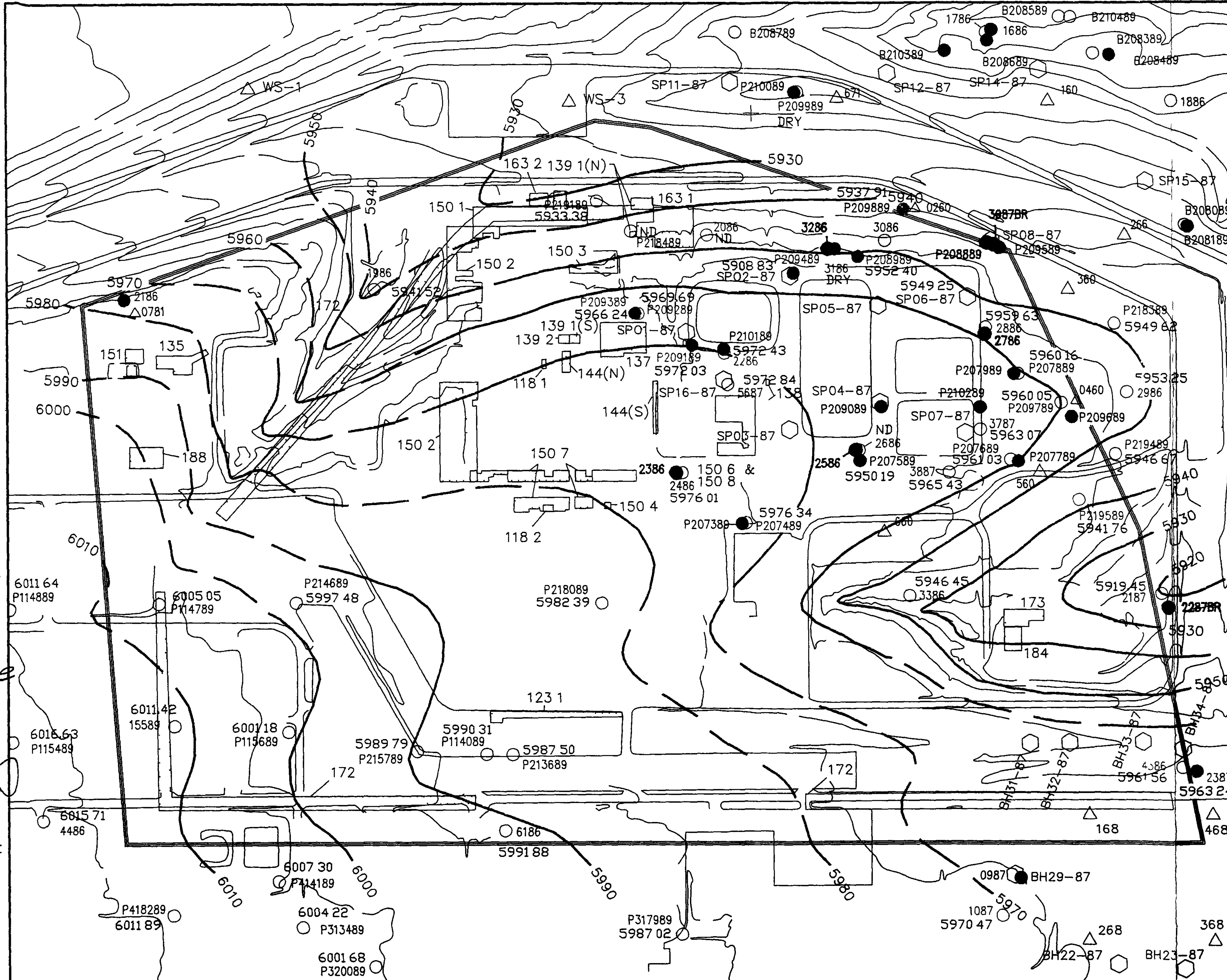
GEOLOGICAL CROSS SECTION
D-D

Approved By [signature] Date 11/23/92



E
P210089 NORTH
P209489
IHSS 138
150 8
P207589
2586
3386
Ties to B-B
IHSS 173
IHSS 184
SOUTH
BH31-87
E'
5980
5970
5960
5950
5940
5930
5920
5910
5900
5890
Elevation in Feet MSL
INTERPRETATION 1
No 1 Sandstone
INTERPRETATION 2
No 1 Sandstone
112-
to
229 ft
573
600
34
461
602
VERT
EXAG X 20
10
0
200
NOTE BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL
File Name OU81-30 DWG
LEGEND
P110189 WELL NO
QUADRANT
SEQUENCE
YEAR DRILLED
GEOLOGICAL LITHOLOGIES
GROUND SURFACE
ARTIFICIAL FILL
CALICHE
COLLUVIUM
CLAY
SILT
SAND
GRAVEL
COBBLES
ROCKY FLATS ALLUVIUM
WELL SCREEN
HSU 1 WATER LEVEL 4/92
TOP OF BEDROCK
INTERBEDDED CLAYSTONES
HSU 1 WATER LEVEL 1/91
SILTSTONES
SANDSTONES
ARAPAHOE FORMATION
OTHER WATER LEVELS
1/91
4/92
No 1 SANDSTONE (Dashed where inferred)
BOTTOM OF WELL
0
200
400
SCALE IN FEET
CONTROLLED AREA
OU8
RFP BOUNDARY
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado
OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN
FIGURE 1 30
GEOLOGICAL CROSS SECTION
E E
Approved By [signature] Date 11/23/92

81/82



File Name OU81-32 DWG

LEGEND

CONTOURS REFLECT DATA POINTS FROM WELLS OPEN TO THE UPPERMOST HYDROSTRATIGRAPHIC UNIT (HSU1)

6042 2 WATER LEVEL ELEVATION ABOVE SEA LEVEL

6012 WATER LEVEL CONTOURS

5996 SURFACE ELEVATION CONTOURS

171 INDIVIDUAL HAZARDOUS SUBSTANCE SITES

OU 8 BOUNDARY

○ ALLUVIAL MONITORING WELL

● BEDROCK MONITORING WELL

HYDROSTRATIGRAPHIC UNIT

4089 SURFICIAL MATERIALS (HSU1)

9189 SURFICIAL MATERIALS / UPPERMOST SANDSTONE IN HYDRAULIC CONNECTION (HSU1)

9489 UPPERMOST SANDSTONE

289 CLAYSTONE

8889 DEEPER SANDSTONE

ALL WATER LEVEL ELEVATION DATA COLLECTED APRIL 1992

CONTOUR INTERVAL 10'

N

SCALE IN FEET

0 300 600

U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

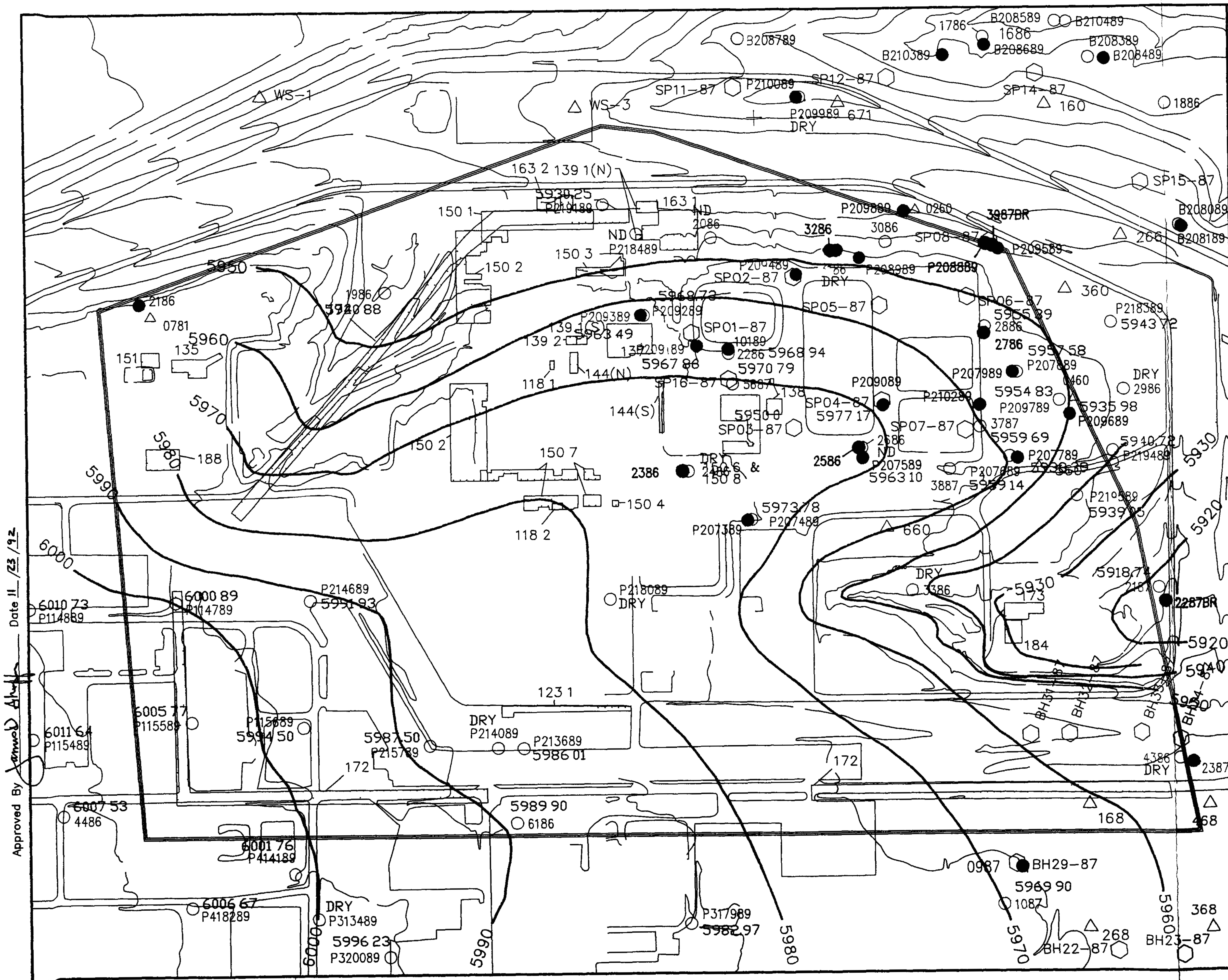
FIGURE 1 32

HIGH WATER LEVEL MAP
UPPERMOST HYDROSTRATIGRAPHIC UNIT

Approved By James D. Shuffer Date 11/23/92

112

82/82



File Name OU81-33 DWG

LEGEND

CONTOURS REFLECT DATA POINTS FROM WELLS OPEN TO THE UPPERMOST HYDROSTRATIGRAPHIC UNIT (HSU1)

6042 2 WATER LEVEL ELEVATION ABOVE SEA LEVEL

6012 WATER LEVEL CONTOURS

5996 SURFACE ELEVATION CONTOURS

171 INDIVIDUAL HAZARDOUS SUBSTANCE SITES

OU 8 BOUNDARY

○ ALLUVIAL MONITORING WELL

● BEDROCK MONITORING WELL

HYDROSTRATIGRAPHIC UNIT

4089 SURFICIAL MATERIALS (HSU1)

9189 SURFICIAL MATERIALS / UPPERMOST SANDSTONE IN HYDRAULIC CONNECTION (HSU1)

9489 UPPERMOST SANDSTONE

0289 CLAYSTONE

8889 DEEPER SANDSTONE

ALL WATER LEVEL ELEVATION DATA COLLECTED JANUARY 1992

CONTOUR INTERVAL 10'

N

SCALE IN FEET

0 300 600

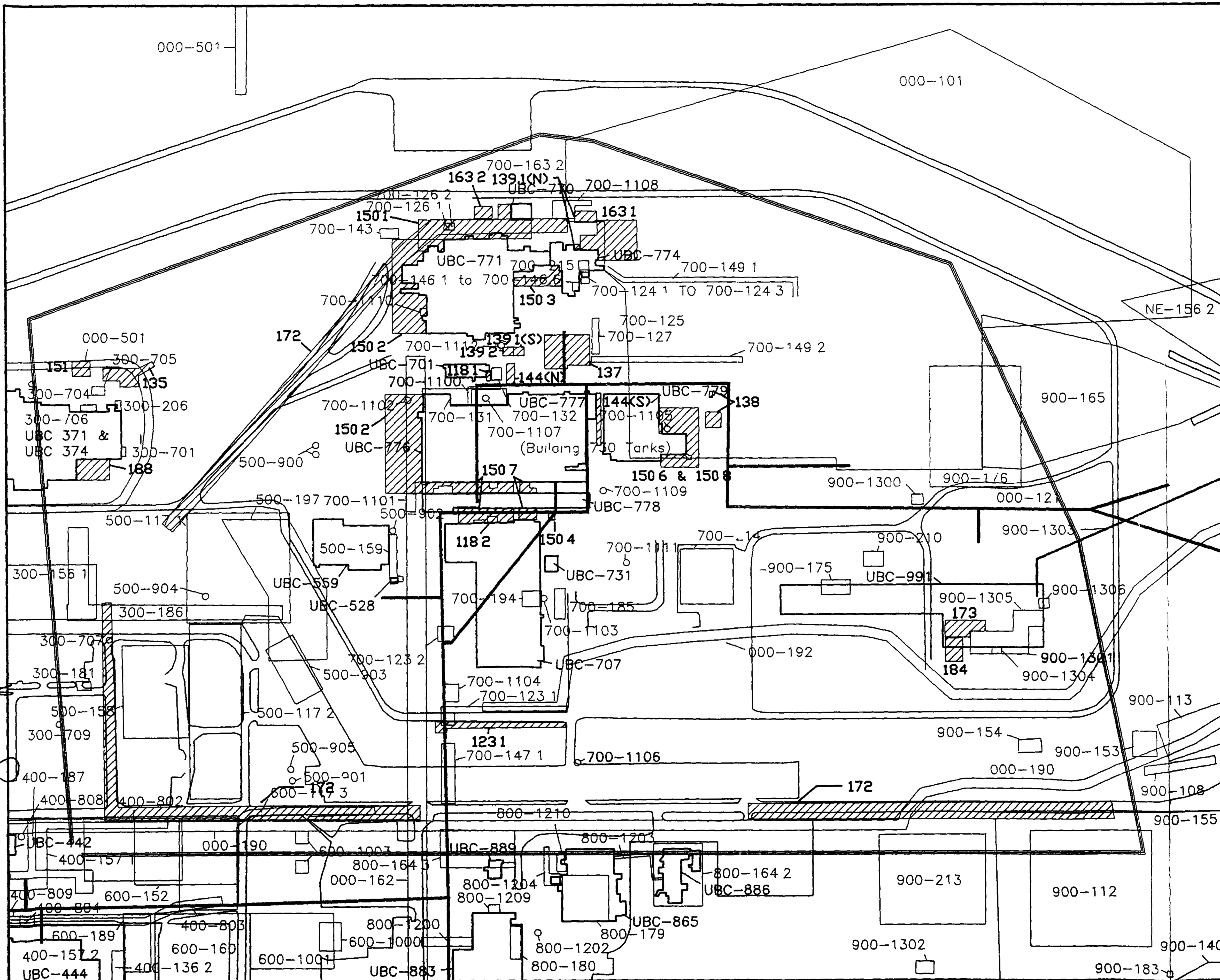
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 1 33

LOW WATER LEVEL MAP
UPPERMOST HYDROSTRATIGRAPHIC UNIT

Approved By [signature] Date 11 /23 /92



File Name OU82-1 DWG

MAP LEGEND

ROADWAYS

OU8 BOUNDARY

137 INDIVIDUAL HAZARDOUS SUBSTANCE SITES CONTAINED WITHIN THE OU8 WORK PLAN

165 INDIVIDUAL HAZARDOUS SUBSTANCE SITES/POTENTIAL AREAS OF CONCERN NOT CONTAINED IN THE OU8 WORK PLAN

UNDERBUILDING CONTAMINATION IN PROXIMITY TO OU8

UBC-731

N

SCALE IN FEET

0 300 600

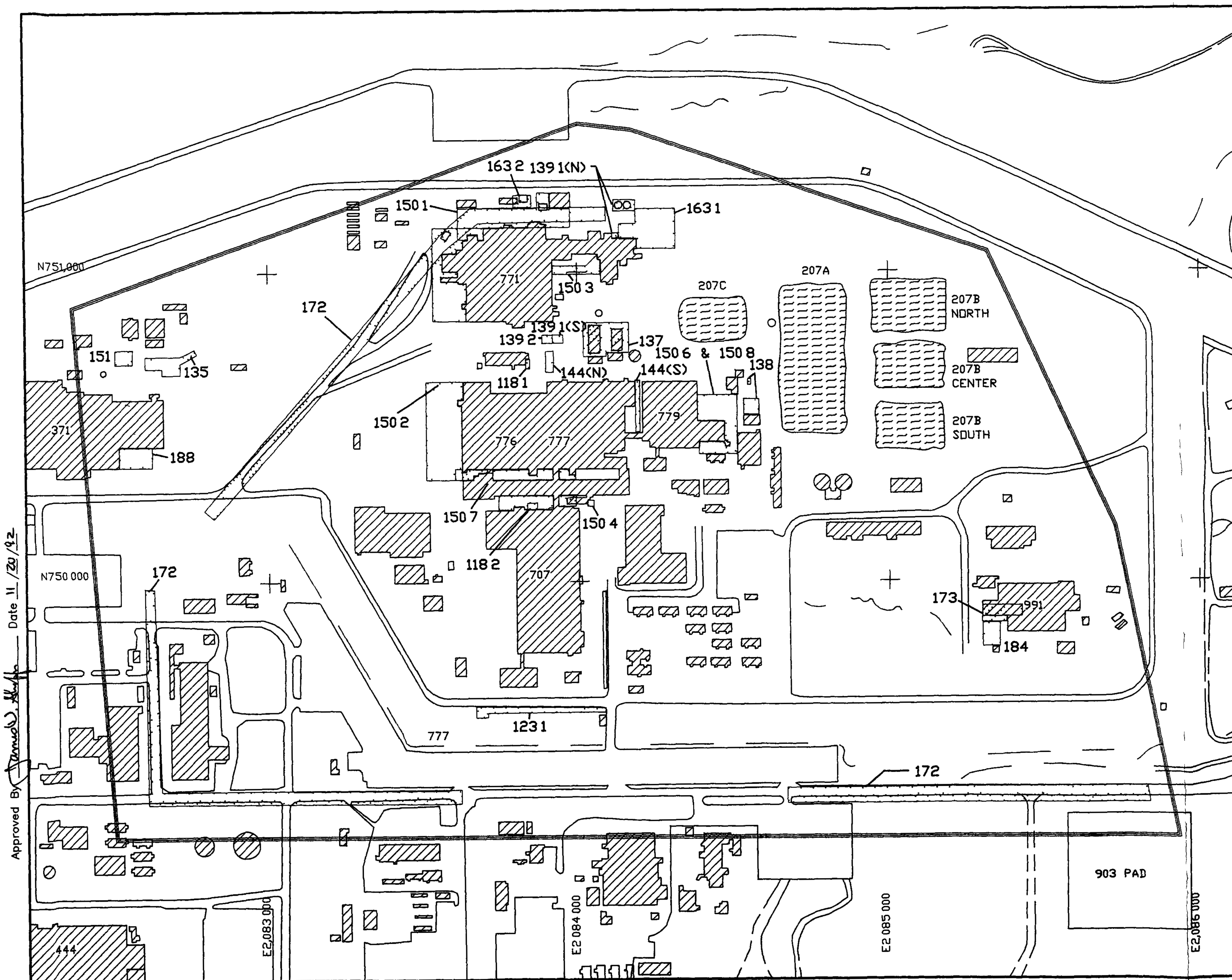
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 2 1

LOCATION OF ALL IHSSs WITHIN OU8 BOUNDARY

240/266



File Name OU81-3 DWG

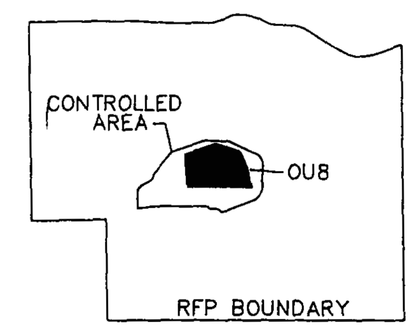
MAP LEGEND

OPERABLE UNIT 8
STREAMS DITCHES DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
SURFACE WATER IMPOUNDMENTS
BUILDINGS
INDIVIDUAL HAZARDOUS SUBSTANCE SITES

N

SCALE IN FEET
0 300 600

Source Groundwater Protection and Monitoring Program Plan ASI Nov 1991



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 2 2

LOCATION OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES OPERABLE UNIT 8 700 AREA

Approved By [signature] Date 11/20/92

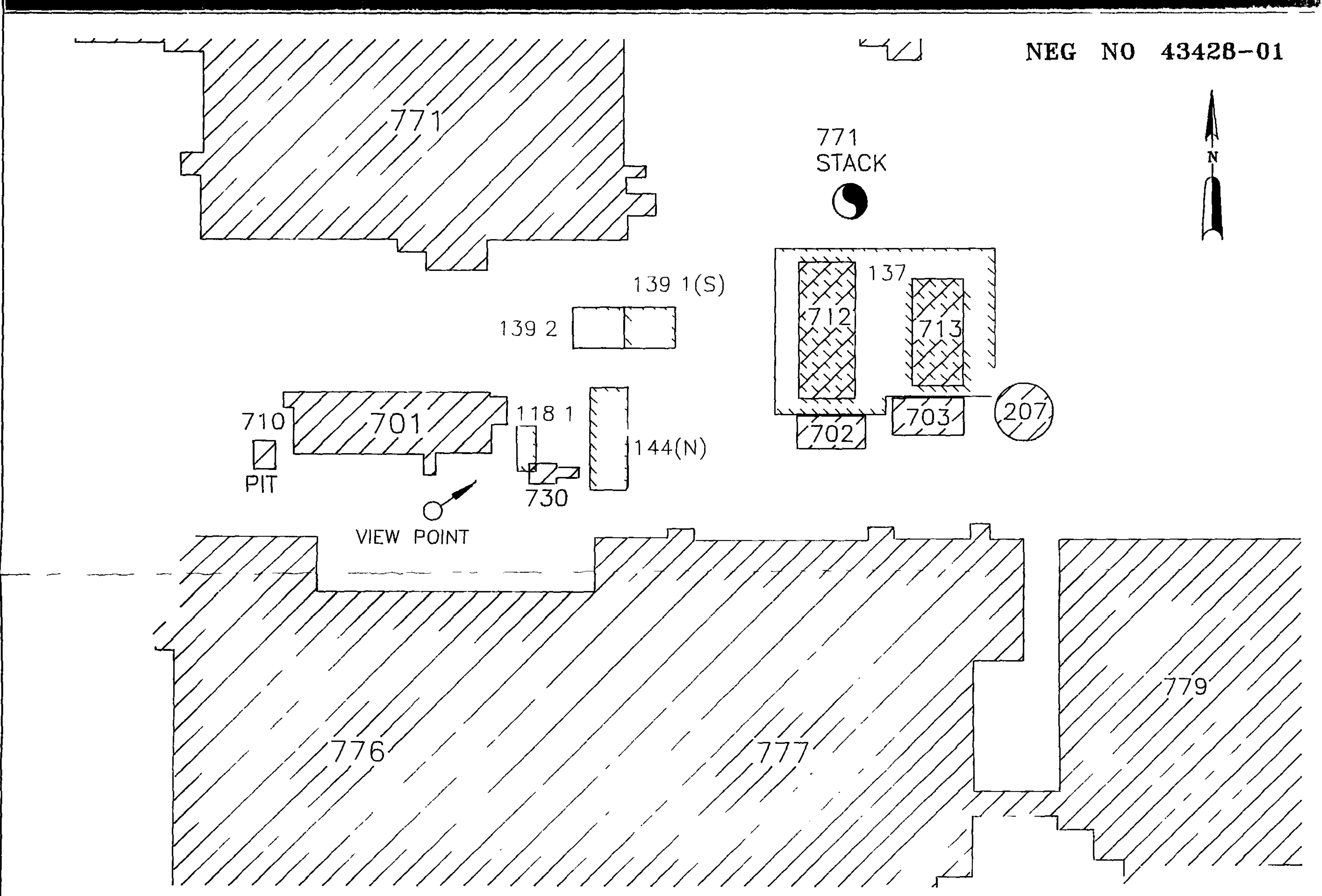


FIGURE 2-3
IHSSs 118 1, 137, 139 1(S), 139 2, and 144(N)

OPFRABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

241/266


NEG NO 43427-05

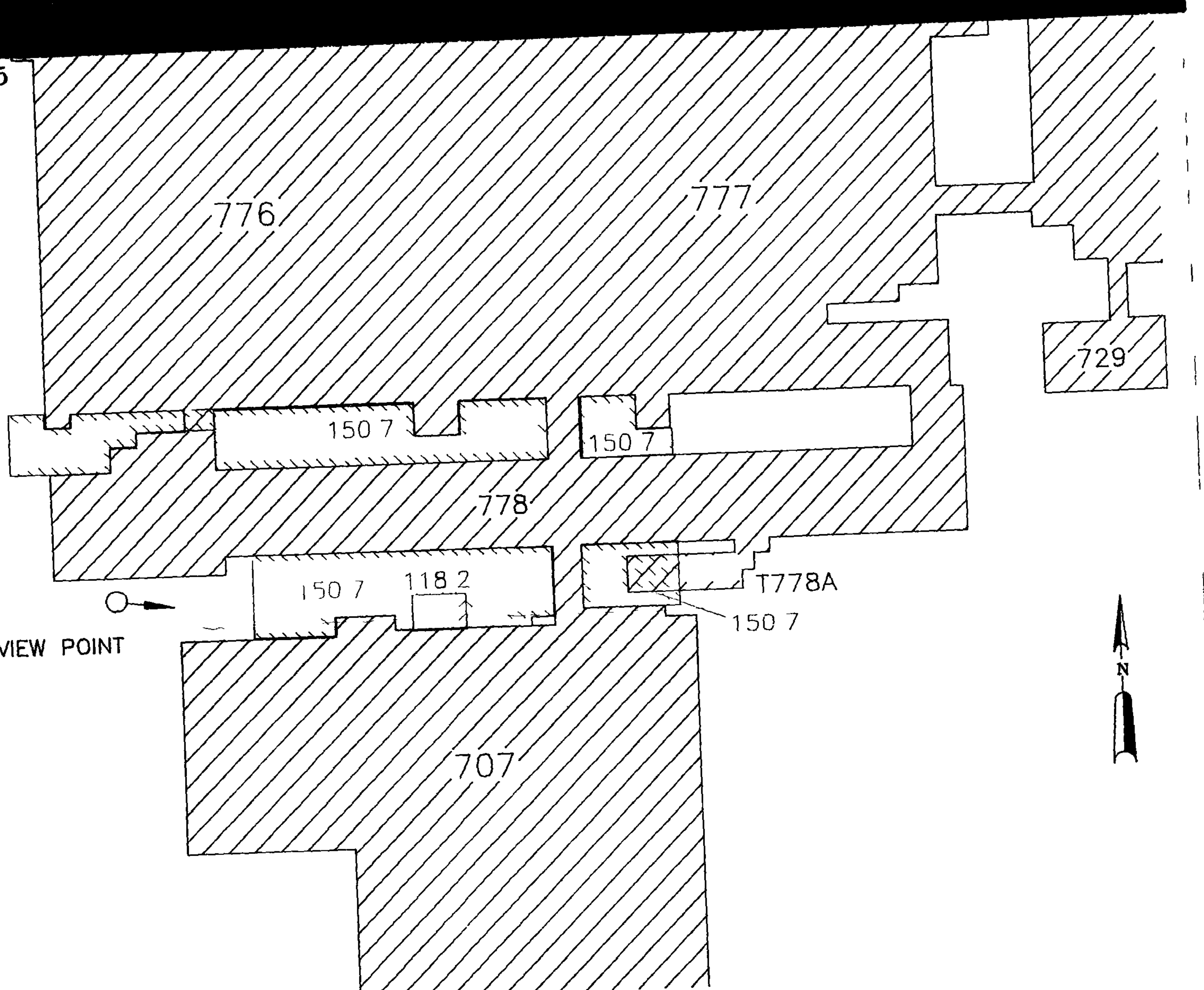
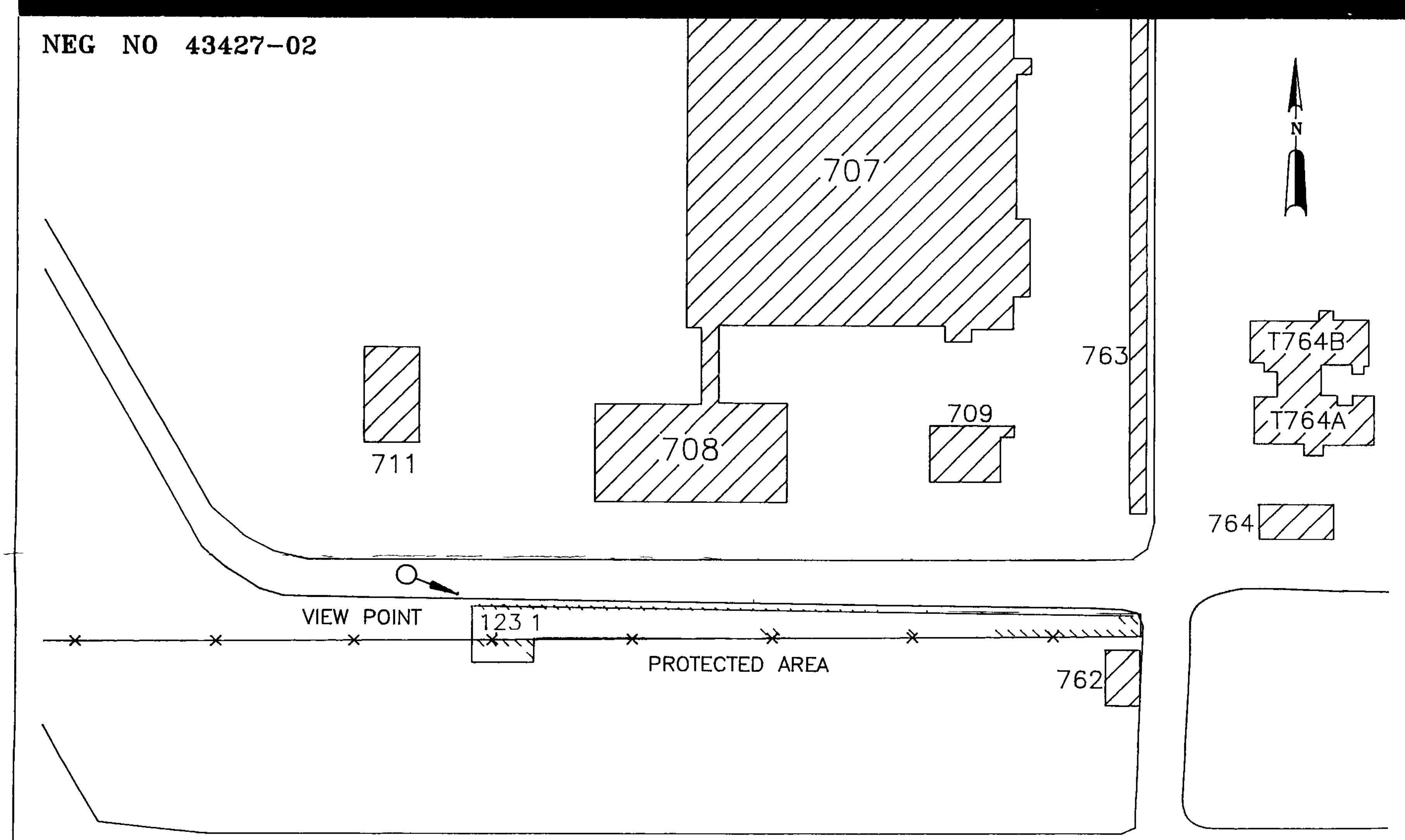


FIGURE 2-4
IHSS 118 2 and 150 7 (partial)

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

NEG NO 43427-02



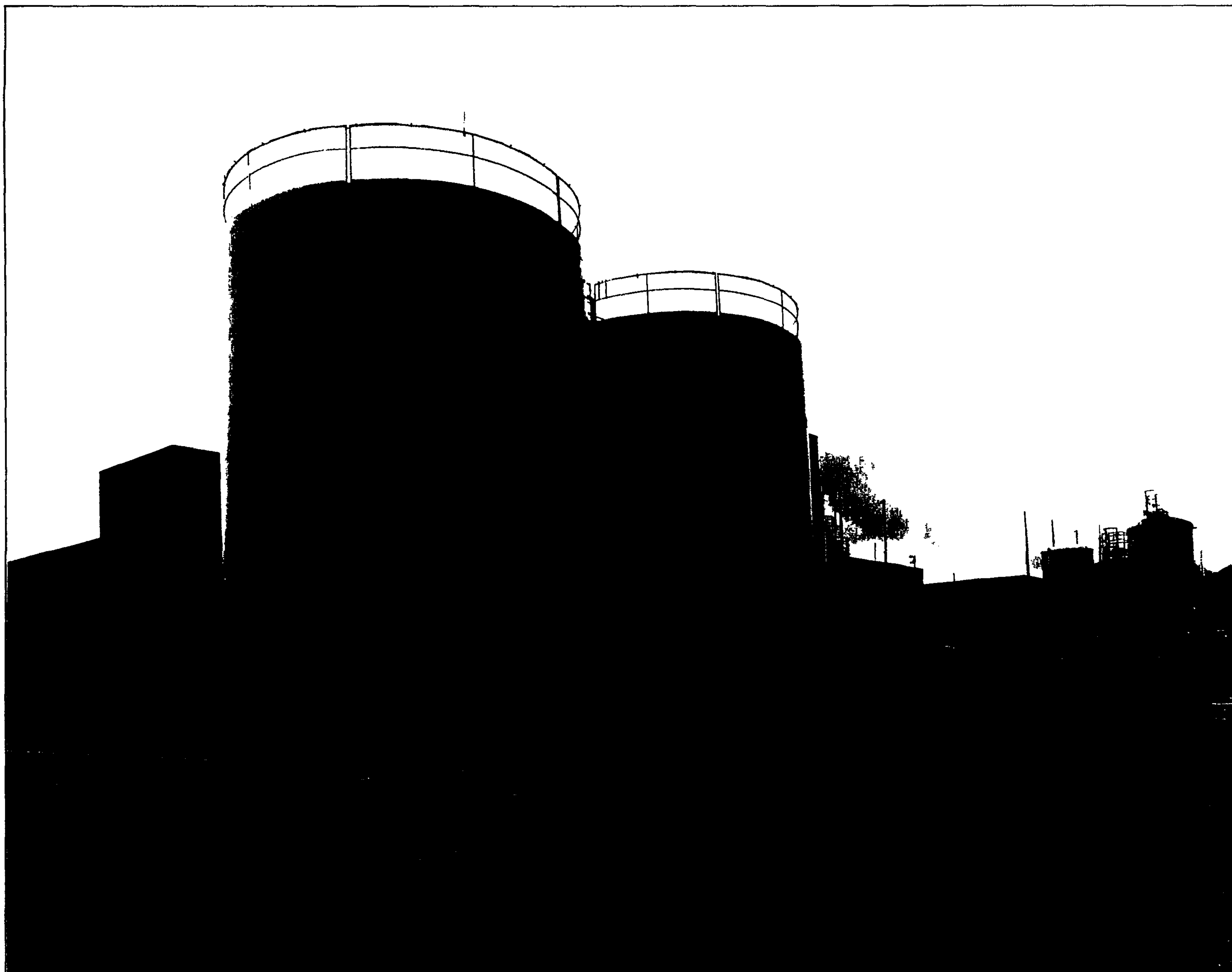
FUGURE 2-5

IHSS 123 1

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

243/266



NEG NO 43969-03

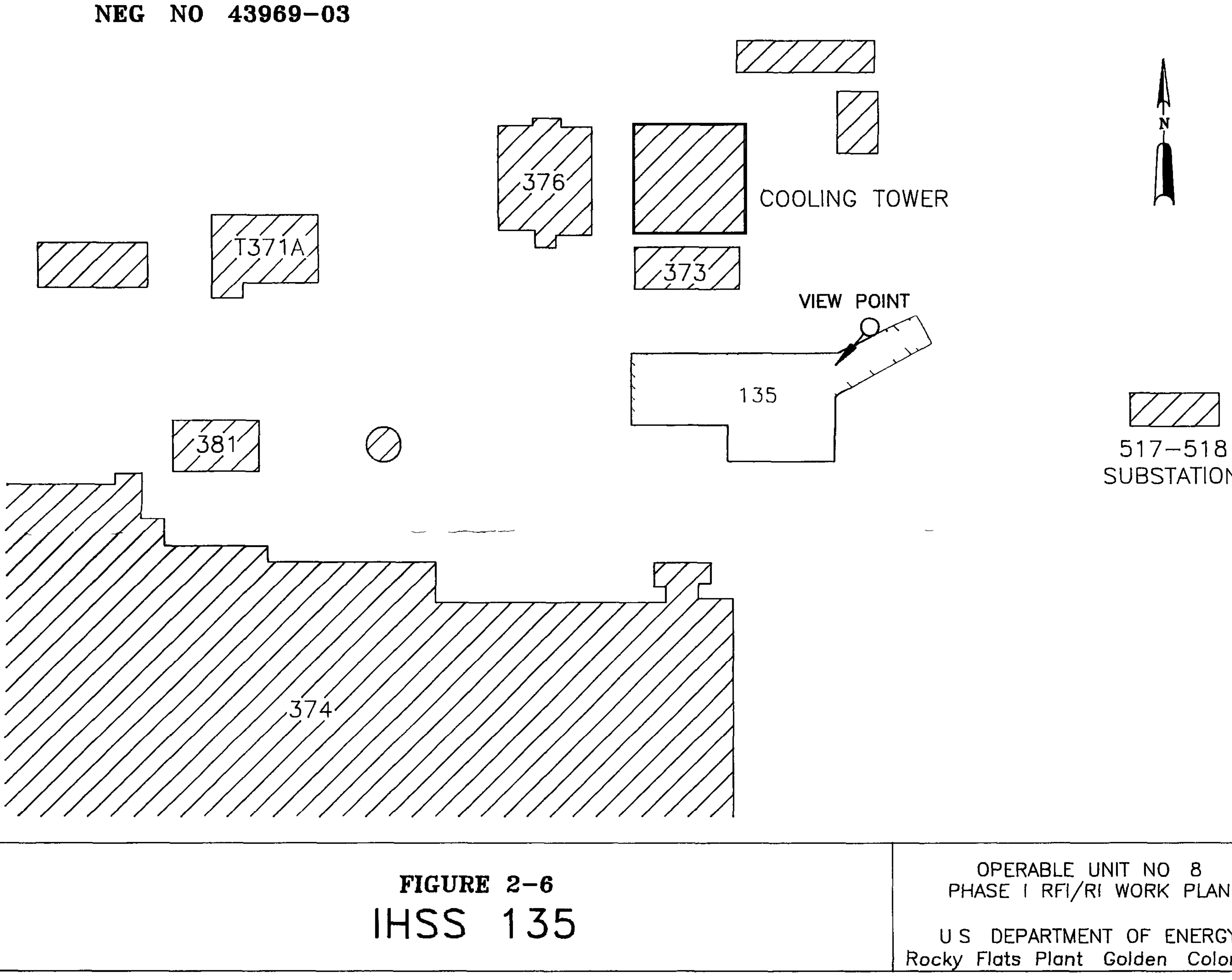


FIGURE 2–6

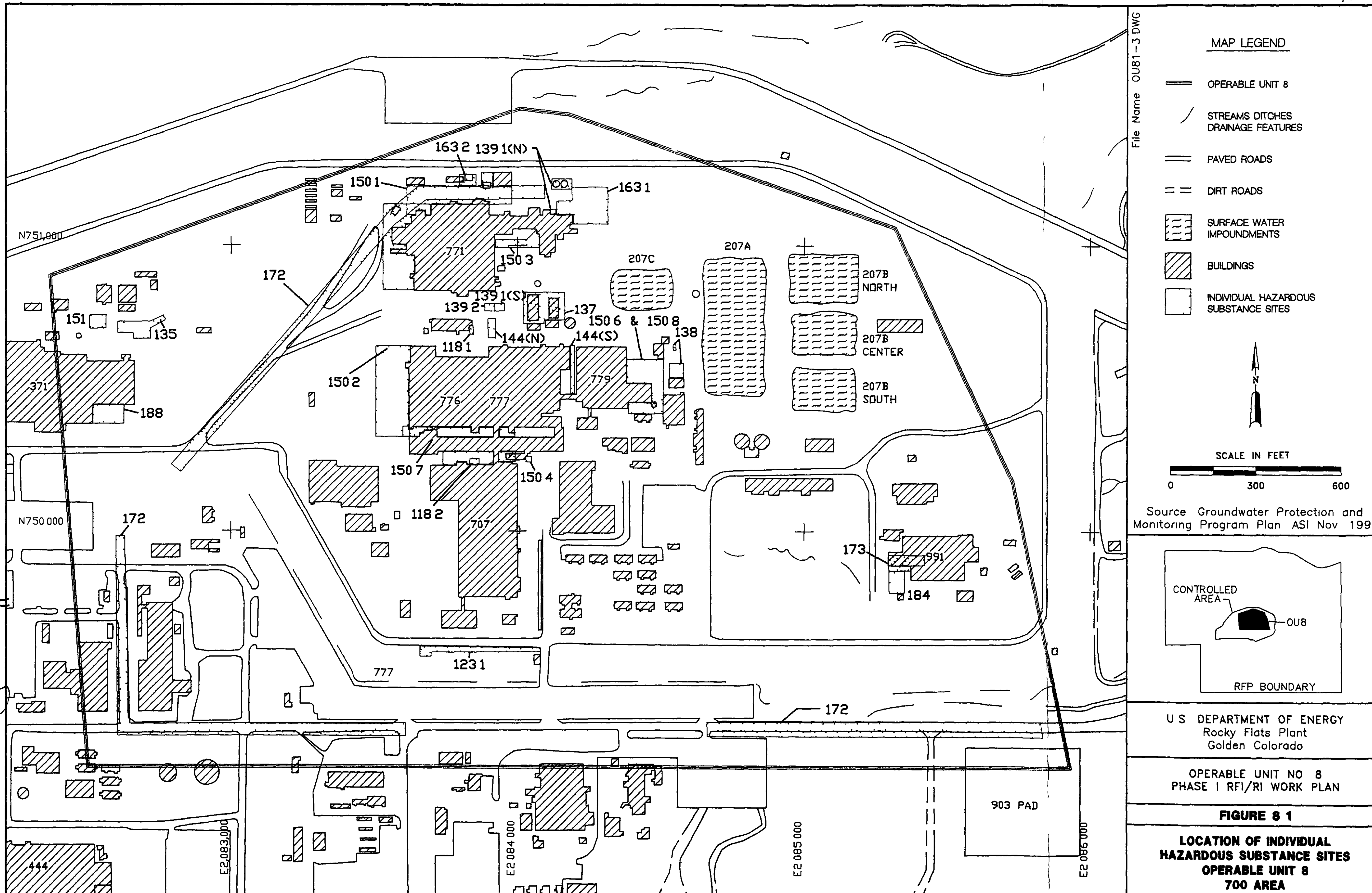
IHSS 135

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

U S DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

244/266

26/28



Source Groundwater Protection and Monitoring Program Plan ASI Nov 1991

File Name OU81-3 DWG

Approved By [signature] Date 11/20/92

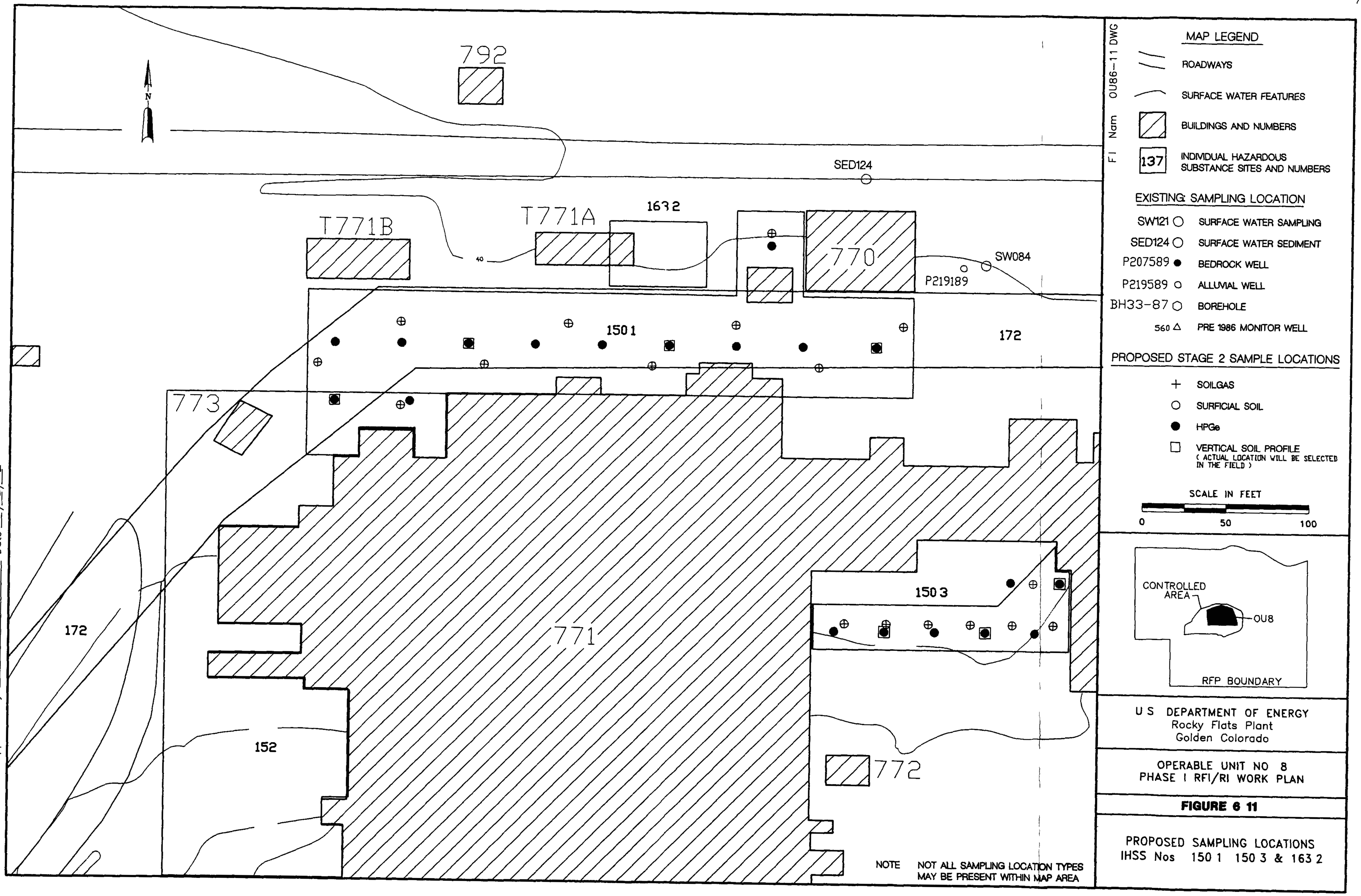
U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO 8
PHASE I RFI/RI WORK PLAN

FIGURE 8 1

LOCATION OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES OPERABLE UNIT 8 700 AREA

97/100



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Golden Colorado

OPERABLE UNIT NO 8
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FIGURE 6 11

PROPOSED SAMPLING LOCATIONS
IHSS Nos 150 1 150 3 & 163 2

App d By P55 Date 11/23/92

92/100

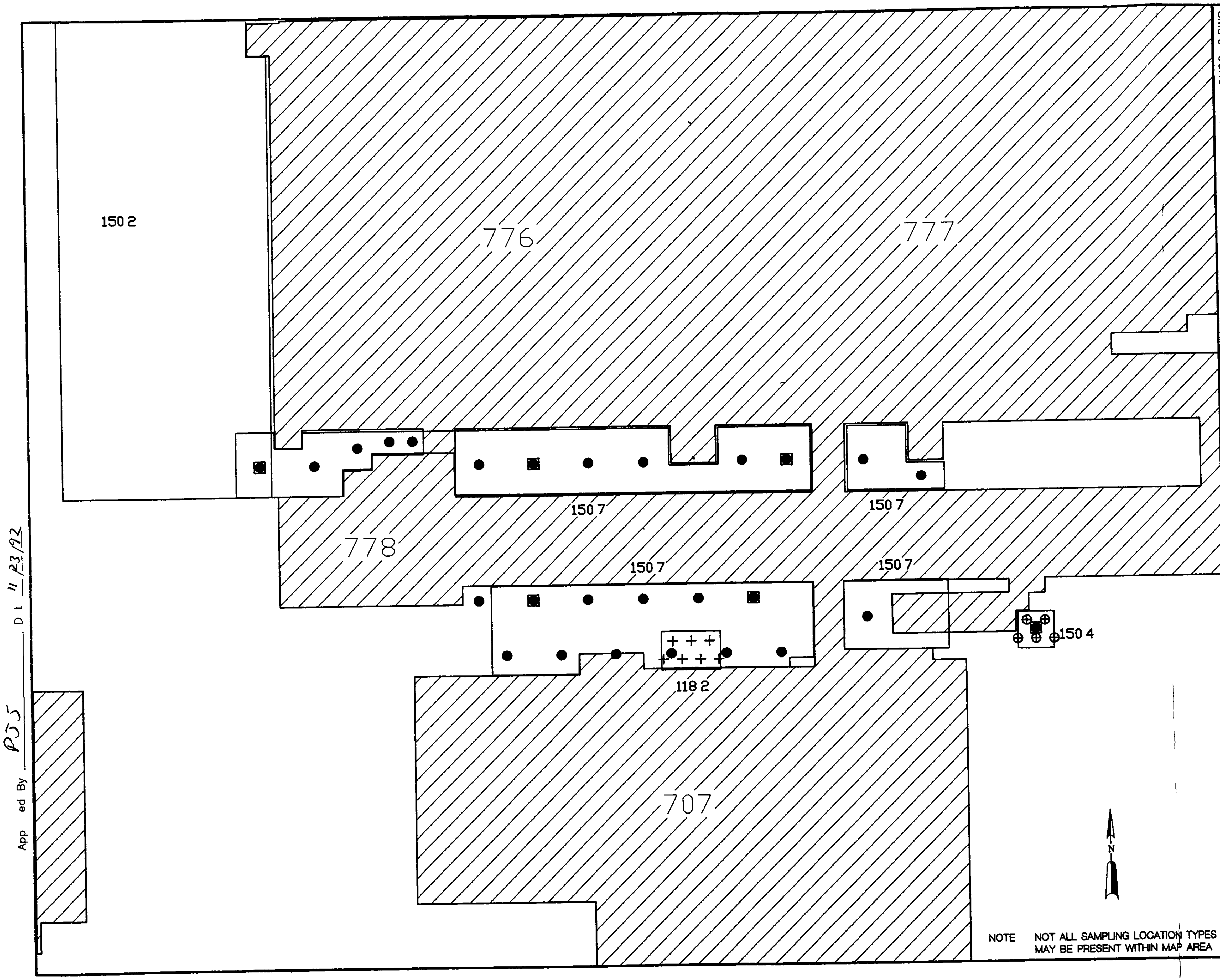

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FIGURE 6 6

PROPOSED SAMPLING LOCATIONS
IHSS Nos 118 2 150 4 & 150 7

App ed By PJJ D t 11/23/92

Appr ed By PJJ D t 11/23/12

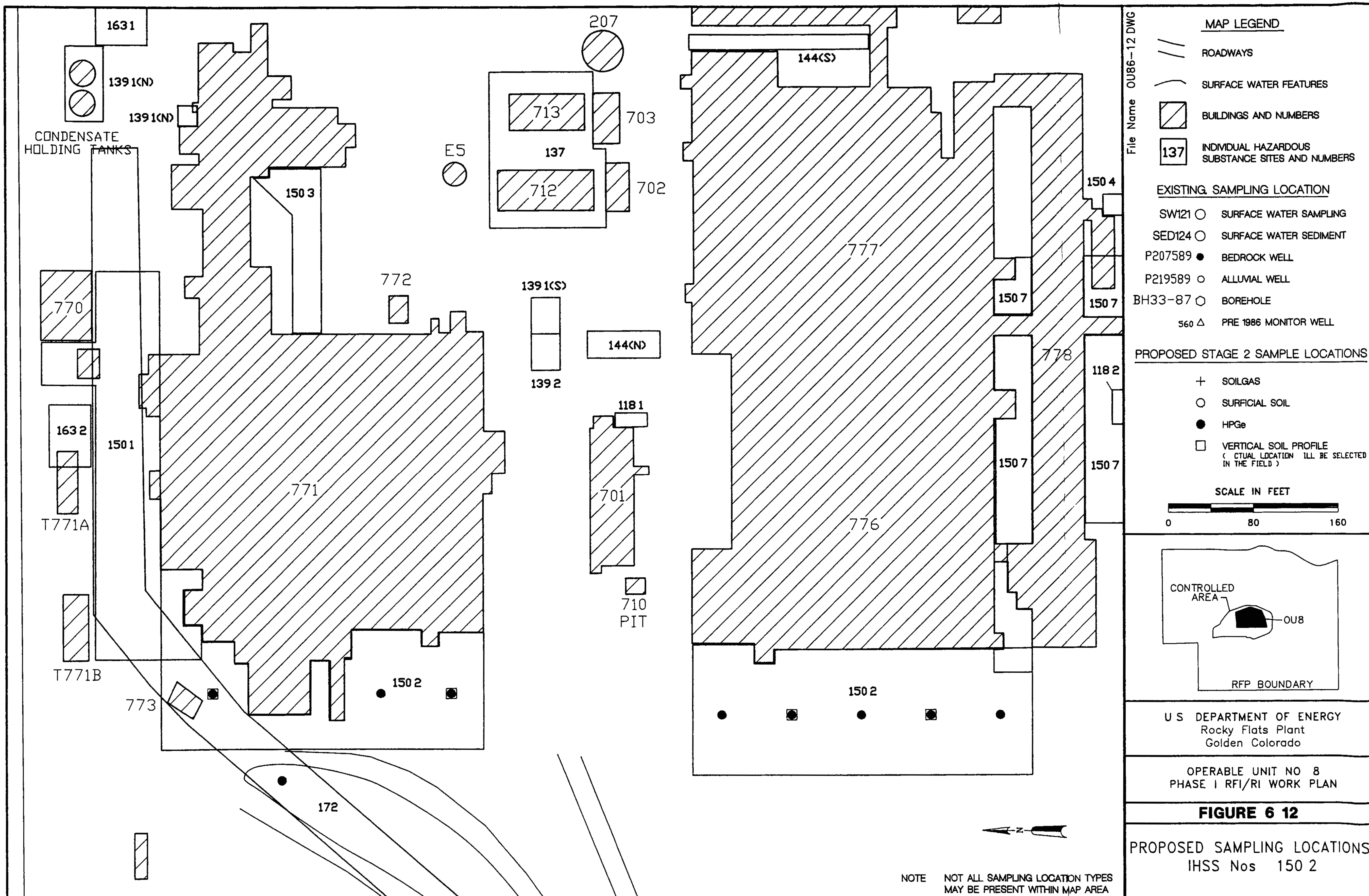

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FIGURE 6 12

PROPOSED SAMPLING LOCATIONS
IHSS Nos 150 2

98/100